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PHILOSOPHICAL MAGAZINE.



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THE

PHILOSOPHICAL MAGAZINE.

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY. *Free*

“Nec araneorum sane textus ideo melior, quia ex se fila gignunt. Nec nostrum vilior quia ex alienis libamus ut apes.” JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.



VOL. I.

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P R E F A C E.

HAVING concluded our First Volume, we would be deficient in gratitude did we not return thanks to the Public, in general, for the favourable reception our labours have experienced; and to those Scientific Gentlemen, in particular, who have assisted us with Communications, as well as Hints respecting the future conducting of the Work.

As the grand Object of it is to diffuse Philosophical Knowledge among every Class of Society, and to give the Public as early an Account as possible of every thing new or curious in the scientific World, both at Home and on the Continent, we flatter ourselves with the hope that the same liberal Patronage we have hitherto experienced will be continued; and that Scientific Men will afford us that Support and Assistance which they may think our Attempt entitled to. Whatever may be our future Success, no Exertions shall be wanting on our part to render the Work useful to Society, and especially to the Arts and Manufactures of Great Britain which, as is well known, have been much improved by the great Progress that has lately been made in various Branches of the Philosophical Sciences.

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THE

PHILOSOPHICAL MAGAZINE.

JUNE 1798.

I. *Account of Mr. CARTWRIGHT's Patent Steam Engine.*

THE steam engine is considered, and with justice, as the first mechanical invention of modern times. The parent idea of this new and stupendous power originated, it is well known, in the fertile mind of the Marquis of Worcester, in the time of the Charles's; though Captain Savary seems to have been the first who actually pointed out to the public its practical application. In his hands, however, it was but Hercules in the cradle. Newcomen and his associate have the merit of bringing it to maturity, and giving to its energies a valuable direction. The principal improvements that have been added to it for the last thirty years, it has received from the hand of the justly celebrated Mr. Watt. From the many fruitless attempts which have been made since the date of Mr. Watt's patent, still further to improve the steam engine, the public has been led to believe, either that it has already arrived at its highest state of perfection, or that its defects admitted not of remedy. These defects, as every one knows, are an imperfect vacuum, much friction, and a complicated construction of parts; liable, without great care and attention, to be frequently out of order. It is to these points Mr. Cartwright has immediately, and, we may add, successfully, directed his attention. His first object seems to have been to obtain, as nearly as may be, an absolute

VOL. I. B vacuum;

vacuum; which, in consequence of the elastic vapour that separates from water injected in the usual mode of condensation, no one in the least conversant with the philosophy of the steam engine need be told is impossible. The condensation, in Mr. Cartwright's engine, is performed by the application of cold to the external surface of the vessel containing the steam. Mr. Cartwright is not, however, the first who tried this method; the same has been attempted by several; but with so little success, that one of our first engineers in this line has been heard to give it as his opinion, that, were a pipe to be laid across the Thames, the condensation would not be quick enough to work a steam engine with its full effect. The manner Mr. Cartwright manages this business is by admitting the steam between two metal cylinders lying one within the other, and having cold water flowing through the inner one, and enclosing the outer one. By these means a very thin body of steam is exposed to the greatest possible surface. But this is not all: by means of a valve in the piston there is a constant communication at all times between the condenser and the cylinder, either above or below the piston, so that, whether it ascends or descends, the condensation is always taking place.

To reduce the friction of the piston, which, when fresh packed in the common way, lays a very heavy load upon the engine, Mr. Cartwright makes his solely of metal, and expansive. There is a further advantage in this method, from the saving of time and expence in the packing, and from the piston fitting more accurately, if possible, the more it is worked.

Mr. Cartwright has been equally attentive in simplifying all the other parts of the engine; his engine having only two valves, and those are as nearly self-acting as may be.

But what will probably be esteemed one of the most important circumstances attending these improvements, is the opportunity they afford of substituting ardent spirit, either wholly or in part, in the place of water, for working the engine. For, as the fluid with which it is worked is made to circulate

circulate through the engine without mixture or diminution, the using alcohol, after the first supply, can be attended with little or no expence. On the contrary, the advantage will be great, probably equal to the saving of half the fuel. When, indeed, the engine is applied, as Mr. Cartwright occasionally purposes, both as a mechanical power and as a still at the same time, the whole fuel will be saved.

A farther advantage of this invention is its applicability to purposes requiring only a small power, and for which any other engine would be too complicated and expensive.

Plate I. represents a section of the different parts of the engine. A is the cylinder, which is supplied with steam from the boiler through the pipe *a*. B the piston, in the act of going up. I the pipe which conducts the steam into C the condenser, being a double cylinder, between which the steam is condensed, and from thence passes through *b* into the pump D. The piston D when going down presses the condensed water upon the valve *c* and shuts it, by which means the water is forced to find a passage through *d* into the air box E. What air or elastic vapour may have been driven along with the water into E rises to the upper part of the box, where acting by its elasticity on the surface of the water, the latter, shutting the valve *b*, is forced through the tube *f*, and by this means returned into the boiler. When the air is collected in such quantity as to force the float *g* to sink to a certain depth, the valve *e* opens, and allows a portion of it to escape.

F the steam valve is opened by the return of the piston B, which raises the rod attached to the under side of F, while at the same time the valve G is shut by its rod being pressed against the top of the cylinder. When the piston B, pressed down by the steam introduced from the tube *a* through the valve F, reaches the bottom of the cylinder, the valve G is opened by its rod touching the bottom, while at the same instant the spring *i* shuts the steam valve F.

HH two cranks, upon whose axes are two equal wheels working in each other for the purpose of giving a rectilinear

direction to the piston rod. M the box that contains the condensing water. K plan of the piston, shewing the metal rings which by the springs LL are forced outwardly against the inside of the cylinder, so that the piston can adapt itself to any inequality that may arise. The piston rod is also made steam tight in the same manner at N. O a part of the fly wheel which regulates the motion.

II. *The Genuine Oriental Process for giving to Cotton Yarn or Stuff the fast or ingrained Colour, known by the Name of Turkey Red, as practised at Astracan. From Neue Nordische Beytrage, by Professor PALLAS.*

A METHOD of giving a fixed red to cotton yarn, so much sought after by the Europeans in the present century, is now known in England, and practised in the southern parts of France; but, as it is not universally known, and as these processes are not only different, perhaps, from the oriental method, but, like the one for dyeing cotton with madder described by Hellot, far inferior to that practised by the Armenians at Astracan, the present information may not be superfluous.

Professor Oettinger at Tübingen made, long ago, in a small publication which appeared in 1764, a discovery which might have led to the secret of the oriental process for dyeing with madder. He there remarked that the beautiful dye of the Turkish yarn, which withstands the strongest solvents, becomes immediately dissolved by common olive oil, in such a manner that the colour may be transferred from a thread of Turkey yarn to any other undyed thread. Hence it clearly appears, that either the dye itself, or the preparing liquor (*appret*), or both, must be of a fat nature, and soluble in oil: and an ingenious artist might have built with advantage on these grounds, as will be sufficiently seen by the following description of the oriental process employed to dye with madder, which I here give exactly as it was related to

me, and I fhall leave the improvement of it to thofe to whofe department it belongs, and who have a tafte for technical chemiftry.

The greater part of the filk and cotton manufactories at Afracan are carried on by Armenians, the number of whom on account of the troublefome ftate of Perfia is continually increafing; and the dye-houfes are kept going only from the firft warm days in the fpring till towards the end of autumn. The madder they employ comes partly by land over Kitzlar from Terek, and partly by fea over Derbent from the Perfian Ghilan. In both places the plant grows wild in the fields in great abundance and great perfection, and is dug up alfo in the uncultivated meads. The roots are generally as thick as the barrel of a quill, fometimes as one's finger, and throughout the whole fpongy part of an agreeable pale red colour: the bark on the other hand is for the moft part very thin, and appears to be of little value. At Terek the frefh gathered roots are placed above each other in a ftove, or in a pit dug in viscus earth which has been ftrongly heated. Earth is then thrown over the madder, and it muft fweat until the ftove or pit becomes cold; when the roots, the fecond or third day, are taken from it, and either fpread out or hung up to dry. The fame procefs is ufual alfo in Perfia, and abundance of madder is brought from the remote parts of that country to Ruffia. At Afracan it is fold, according to the importation, at from four to feven rubles for every forty pounds.

This madder is ground at Afracan, for the ufe of the dyers, in horfe-mills kept by the common people, and con- ftructed in the following manner: In the middle of the mill, which is built on a level fpot of ground, a circular place is walled round with bricks to the height of four fpan, the inner face of which is made to flope gently from the circumference towards the centre, and a groove goes round the infide of this brick-work to receive the mill-ftone. The whole furface of the brick-work is covered with plane fmooth boards, and in the middle of it ftands a perpendicular

spindle, which at the top is inferted in a crofs beam, and at the bottom refts in a focket. The spindle is turned by means of an oblique beam paffing through it, to the fhorter end of which is faftened a mill-ftone moveable like a wheel round its axis, and a horfe is yoked to the other end, which reaches beyond the brick-work. The madder, which has been well dried in the fun, muft be firft coarfely broken in the groove under the mill-ftone, and afterwards ground until it become a very fine powder.

In the fame mills are ground the round leaves of the fumach (*rbus cotinus*), which gives a yellow dye, and which is brought to Afracan from the neighbourhood of Terek, where it grows wild under the Tartarian name *balga*, or, as the Armenians exprefs it, *belge*, and is employed fometimes in dyeing with madder, fometimes in dyeing dark yellow, and fometimes in the preparation of Turkey leather. Thefe leaves, when whole, have a pleafant green colour; but when bruifed they exhibit that yellow dye with which they are impregnated, and which is produced alfo by the woody part and branches: but as thefe are not fo eafily cleaned, they are carefully feparated from the ground duft of the leaves by means of a fieve. A pud or forty pounds of thefe leaves, in the ftate in which they are brought to Afracan, cofts five, fix, and often feven and a half rubles.

The dye-ftuffs neceffary for dyeing red, befides the two already mentioned, are gall-nuts, alum, an indigenious had kind of foda, called *kalakar*, which is burnt in the wilds of Kiflar and Afracan, from the fal fuginous or foda plants, that grow there in abundance, and laftly fifh-oil. The latter is boiled in the fifheries on the lower part of the Volga, and on the Cafpian fea, from the entrails of the fturgeon and other large fifh, but chiefly from thofe of the *perca lucio-perca*, the fhad, and other kinds little efteemed in thofe parts. The proof of its being proper for dyeing is, that when mixed with a lixivium of foda it muft immediately affume a milky appearance. Shou'd that not be the cafe, it cannot be ufed by
the

-the dyers. The soda is burnt partly at Kislar by Armenians, and partly in the wilds of Astracan by the Calmucks. The latter, because it is very impure, sells at Astracan for only fifteen copeks per pud, but the former is worth more than thirty.

The cotton to be dyed red is first washed exceedingly clean in running water, and, when the weather is clear, hung up on poles to dry. If it does not dry before the evening, it is taken into the house, on account of the saline dews so remarkable in the country around Astracan, and again exposed to the air next morning. When it is thoroughly dry it is laid in a tub, and fish-oil is poured over it till it is entirely covered. In this state it must stand all night, but in the morning it is hung up on poles, and left there the whole day; and this process is repeated for a week, so that the cotton lies seven nights in oil, and is exposed seven days to the atmosphere, that it may imbibe the oil and free itself from all air. The yarn is then again carried to a stream, cleaned as much as possible, and hung up on poles to dry.

After this preparation a mordant is made of three materials, which must give the grounds of the red colour. The pulverised leaves of the sumach are first boiled in copper kettles; and when their colouring matter has been sufficiently extracted some powdered galls are added, with which the liquor must be again boiled; and by these means it acquires a dark dirty colour. After it has been sufficiently boiled the fire is taken from under the kettle, and alum put into the still hot liquor, where it is soon dissolved. The proportion of these three ingredients I cannot determine with sufficient accuracy, because the dyers make use of different quantities at pleasure. The powder of the sumach leaves is measured into the kettle with ladles; the water is poured in according to a gauge, on which marks are made to shew how high the water must stand in the kettle to soak six, eight, ten, &c. puds of cotton yarn. The galls and alum are added in the quantity of five pounds to each pud of cot-

ton. In a word, the whole mordant must be sufficiently yellow, strong, and of an astringent taste.

As soon as the alum is dissolved, no time must be lost in order that the mordant may not be suffered to cool. The yarn is then put into hollow blocks of wood shaped like a mortar, into each of which such a quantity of the mordant has been poured as may be sufficient to moisten the yarn without any of it being left. As soon as the workman throws the mordant into the mortar, he puts a quantity of the yarn into it, and presses it down with his hand till it becomes uniformly moistened, and the whole cotton yarn has struck. By this it acquires only a pale yellow colour, which however is durable. It is then hung up on poles in the sun to dry; again washed in the stream, and afterwards dried once more.

By the yellow dye of the sumach leaves, the madder dye becomes brighter and more agreeable; but the galls damp the superfluous yellow, and together with the alum prepare the yarn for its colour. Some dyers however omit the use of these leaves altogether, and prepare their mordant from galls and alum only, by first boiling the galls in due proportion with the requisite quantity of water, then dissolving the alum with boiling water in a separate vessel, afterwards pouring both liquors together into a tub, and suffering the cotton to remain in them an hour, or an hour and a half; after which it is dried gradually, then washed, and again dried once more. By this process the yarn acquires a dirty reddish colour.

The next part of the process is to prepare the madder dye. The madder, ground to a fine powder, is spread out in large troughs, and into each trough is poured a large cup full of sheep's blood, which is the kind that can be procured with the greatest facility by the dyers. The madder must be strongly mixed in it by means of the hand, and then stand some hours in order to be thoroughly soaked by it. The li-

quor

Oriental Process for dyeing Red.

quor then assumes a dark red appearance, and the madder in boiling yields more dye.

After this process water is made hot in large kettles, fixed in brick-work; and as soon as it is warm the prepared red dye is put into it, in the proportion of a pound to every pound of cotton. The dye is then suffered to boil strongly; and when it is enough, which may be tried on cotton threads, the fire is removed from under the kettle, and the prepared cotton is deposited near it. The dyer places himself on the edge of the brick-work that encloses the kettle; dips the cotton yarn, piece by piece, into the dye; turns it round, backwards and forwards; presses it a little with his hands; and lays each piece, one after the other, in pails standing ready for the purpose. As soon as all the cotton has received the first tint, it is hung up to dry: as the red, however, is still too dull, the yarn which has been already dyed once, and become dry, is put once more into the dyeing-kettle, and must be left there to seethe for three hours over a strong fire, by which it acquires that beautiful dark red colour which is so much esteemed in the Turkey yarn. The yarn is now taken from the dye with sticks; the superfluous dye which adheres to it is shaken off; the hanks are put in order, and hung up, one after another, to dry. When it is thoroughly dry, it is washed in the pure stream and again dried. The only fault of the Astracan dyers is, that the colour is sometimes brighter and sometimes darker, probably because they do not pay sufficient attention to the proportions, or because the madder is not always of the same goodness.

In the last place, the abovementioned soda (kalakar) is dissolved with boiling water in tubs destined for that purpose, and it is usual here to allow twenty pounds of soda to forty pounds of cotton, or half the weight. Large earthen jars, which are made in Persia of very strong clay, a yard and a half in height, almost five spans wide in the belly, and ending in a neck a span and a half in diameter, enclosed by means of cement in brick-work over a fire-place, in such a manner

manner that the necks only appear, are filled with the dyed cotton yarn. The ley of diſſolved ſoda, which is blackiſh and very ſharp, is then poured over it till the jars be filled; and ſome clean rags are preſſed into their mouths, that the uppermoſt ſkains of yarn may not lie uncovered. A fire is then made in the fire-place below, and continued for twenty-four hours; and in the mean time the ſteam which ariſes from the jars is ſeen collected among the rags in red drops. By this boiling the dye is ſtill more heightened, and is made to ſtrike completely; every thing ſuperfluous is removed, and all the fat matter which ſtill adheres to the yarn is waſhed out: nothing more is then neceſſary for completing the dye of the yarn but to riſe it well ſeveral times in running water, and then to dry it.

That the dye of madder might be made very penetrating by other methods, and through the means of other oily and refinous ſubſtances, is ſhewn by the proceſs of the Tunguſians to dye horſe', goat's and rein-deer's hair, which they uſe for ornamenting their dreſſes, of a beautiful red colour, by the roots of the croſs-wort, or northern madder (*gallium*), and narrow-leaved woodroof (*aſperula tinctoria*), which have a reſemblance to thoſe of madder. They boil the freſh or dried roots with about the ſame quantity of agaric (*agaricus officinarum*), which, as is well known, is abundant in refinous gummy particles, and is uſed by the people of Jakut inſtead of ſoap; they then lay in it the white hair which they wiſh to dye, and ſuffer it to ſeethe ſlowly until it be ſufficiently red.

Cotton cloth is dyed with madder at Aſtracan in the ſame manner: but many purſue a fraudulent proceſs, by dyeing with red wood, and then ſell their cloth as that which has been dyed in the proper manner.

NOTE BY THE EDITOR.

One circumſtance in the preceding proceſs deſerves particular attention, as it furniſhes a hint which, if properly followed

lowed up, may perhaps enable our dyers to give to cotton all, or at least a number of the colours which at present can only be communicated to woollen. We allude to the use of fish oil and sheep's blood, both of which animal substances are considered as being indispensably necessary to the success of the operation.

Mr. Vogler, an able German chemist, after long and frequent trials to give to linen and cotton a lasting black colour, found that, to gain this end, it was previously necessary to dip the yarn or stuff into a solution of glue in water, in such proportion as to give to the water when warm, being tried between the fingers, a sticky or glutinous consistence; and recommends that care be taken only to wring, not to wash out the glue-water, part of which must be allowed to dry upon the yarn. Professor Beckmann has noticed similar circumstances.

The inference, as has been observed by M. Berthollet and others, is, that to succeed in giving some particular fixed colours to vegetable productions, it is necessary that they be previously animalised, as it were, by the application of oil, blood, glue, or other animal matter.

III. *Method of purifying Lead from Gold and Silver, so as to make it fit for the Purpose of Assaying.* By PET. JAC. HJELM. From the New Transactions of the Royal Academy of Sciences at Stockholm.

ON many occasions, particularly in trying the fineness of gold, it is necessary to employ lead free from the mixture of any other metal. For such experiments, above all, one must not make use of lead which already contains gold or silver, or both these metals, without knowing the quantity, which, at all times, occasions difficulty and often uncertainty. In its natural state lead, for the most part, is found so mixed with

with these noble metals, that after being smelted it cannot be employed for the above purpose; and though there be lead ore which exhibits only a very few or no traces of their presence, and in the first case the proportion must never be more than a quarter of a grain in the pound (*mark*), it is exceedingly rare in the common course of mining to find pieces of such a nature, and people often have not leisure to search for them. As I have sometimes been exposed to great inconvenience for want of a proper piece of lead, I endeavoured to find out an easy method of procuring, without a tedious process, such a quantity of pure lead as would be sufficient for the before-mentioned test; and as I do not remember to have heard of its being any where described or employed, I have reason to think that an account of it may be of some use, at least in the art of assaying, in case a more extensive application of such a smelting process be not possible on a large scale, or if it should not be found profitable. When one begins to reflect on this object, the first idea that occurs is to accomplish the end in view, by dissolving the lead in an acid, and then precipitating either the lead or the finer metals; but on closer examination there is no process of this kind which will not be either too expensive, when it is necessary to prepare several pounds at once, or require longer time than one can possibly bestow. For these reasons I gave up this method, and adhered to that only which was performed merely by fusing in a crucible with the assistance of a requisite degree of heat.

First Experiment.

Litharge, a cheap article that can be easily procured, was the first substance with which I thought it necessary to make experiments. As it seemed possible that it might be free from any mixture of silver, that circumstance was first examined before I proceeded further. I then melted some ounces of litharge with equal quantities of pot-ash and tartar; but the lead obtained from this mixture contained still about half a grain

grain in the pound. It was therefore of no use for proofs by scorification and for assaying; and the principal point now was to free the litharge from its mixture. This object I accomplished by a few meltings, in the following manner:

I placed a crucible, in which half a pound of litharge found good room, and which was fitted with a close cover, in a wind-furnace filled with dead coals. I then put into the crucible a mixture of four ounces of potash and the same quantity of powder of flint. When the whole was well melted by strengthening the draught and making the coals glow, I took off the cover, and laid hold of the crucible with a pair of tongs, in order to take it out, and to suffer this very fusible glass to cover the inside of the crucible, to secure it from the glass of the lead which I meant to melt in it. The superfluous glass was poured out; the crucible again placed on its foot, and half a pound of litharge thrown into it with a shovel. The cover was placed upon it while the litharge was melting; and when it was thoroughly glowing and fluid, charcoal dust was sifted into the uncovered crucible through a sieve, so that the surface of the litharge was completely covered with it. This immediately produced an effervescence, and the rising of bubbles, by means of the separation of the air occasioned by the reduction of the lead. During this process the cover was put on and a few coals thrown into the furnace: when these were burnt every thing in the crucible was quiet, and the melted mass was poured into a warm conical mould. The crucible was then again filled with half a pound of the same kind of litharge, and put into the furnace, and charcoal dust was several times sifted over the melted surface, till it was well covered before the mass was thrown out, a sufficient space being every time left for the effervescence. The first mass had, in the mean time, become cool, and, on examination, contained four ounces of lead at the bottom, and litharge at the top. When this litharge was reduced with potash and crude tartar, the lead thence obtained,

tained, which weighed 23 ounces, was found to contain less than $\frac{1}{2}$ grain of silver in the pound. In the second mass there was found somewhat more than six ounces of lead, which contained all the silver that had been before mixed with the litharge, because in the lead which had been reduced from the litharge in the above manner there were no perceptible traces of silver. This lead was then melted over a slow fire, and cast into bars, which were rolled smooth and formed into masses of a known weight, to be used for assaying gold and silver, and for other purposes of the same kind. All these meltings were made in one crucible, which, according to every appearance, remained unhurt. If the same experiments were made with red lead, the like result would infallibly follow.

The cause of this process, and of the effects thence produced, is, that when lead, which contains a small quantity of silver, is calcined and brought into the state of litharge, the silver in it, if not scorified, is diffused in infinitely fine particles, so that it is impossible for it to sink through the melted litharge and settle at the bottom. When the lead calx is revived on the surface, the leaden grains, as they are formed, sink down through the litharge, and carry with them the scattered grains of silver, in so far as this leaden shower, if I may so name it, is compact and powerful enough to collect them. Were the opinion of those just, who assert that a calx of lead free from silver, when revived by tartar, acquires again, by the creation of new silver, a portion of that metal, litharge ought not to be revived by tartar, or any thing of the like kind from the vegetable kingdom; but on this occasion I found no such effect produced.

Second Experiment.

With the same view of obtaining lead free from silver, I melted, in the like manner, half a pound of white lead, which produced half an ounce of lead. When the litharge standing over it was revived, the lead obtained was still
found

found to contain too much silver. I therefore precipitated another half pound of white lead by charcoal powder, after the lead that fell from it had been separated; and then it produced, by reviving, a mass of lead without any mixture of silver.

Third Experiment.

Cupels, employed for refining silver, imbibe about the half of their weight of lead calx. One might therefore believe, that when this lead calx is revived it would produce lead free from silver. Besides the observation of others, which confirms the contrary, I have made experiments with the ashes of such cupels in which assaying had been performed with the utmost accuracy; but I found that the lead thence made into ingots contained sometimes more than one quarter of a grain of silver in the pound. The bone ashes, from which cupels are generally cast, are, by themselves, almost infusible; and this, on account of the great number of fluxes which must be employed to bring them to a fluid state, makes the fusion of them difficult and expensive. To four parts of fine pounded cupel ashes, I put four parts of potash, four parts of salt, three parts of tartar, and one part of clay, which mixed together produced, after being melted, $1\frac{1}{4}$ part of lead, making almost 44 parts in the hundred*. But this still contained the above-mentioned quantity of silver, and could not therefore be proper for the proposed end.

As the two first-mentioned experiments will completely answer the purpose, it is perhaps unnecessary to seek for other methods; as it will be hardly possible to find any less complex, or easier to be put in practice.

* There must here be an error in the original. Instead of $1\frac{1}{4}$ part of lead, we ought, perhaps, to read $1\frac{1}{2}$

IV. *On the Irregularity in the Rate of Going of Time-pieces occasioned by the Influence of Magnetism. An original Communication, by Mr. VARLEY.*

HAVING studied the theory of clock and watch-making many years, as well as been, part of that time, concerned in an extensive manufactory of watches, I have had many opportunities of observing a circumstance which has surprised every one in the trade as well as myself; that watches of considerable price, and from the hands of excellent workmen, often perform no better than a plain one of inferior workmanship and much lower price. Being anxious, as may naturally be supposed, to furnish my friends with watches or clocks which would go well, I made it my business to pay particular attention to whatever could contribute to their perfection. With this view, I made almost numberless experiments and observations on the various escapements now in use, the different constructions of balances, pendulums, pendulum springs and compensations, both for clocks and watches, which have been applied by very ingenious mechanics and excellent workmen to correct the errors in the rate of going, especially of watches, occasioned by the various degrees of heat and cold, change of position, external agitation, influence of oil, friction, variation of maintaining power, and other causes.

Some of these contrivances are extremely well adapted to answer the intended purpose; but, notwithstanding all their advantages, the maker and purchaser are frequently disappointed in the performance of the machine to which they are applied. Many instances might be produced where the best workmen have been employed, no expence spared by the maker, and the above-mentioned improvements applied with the utmost care and attention; and yet the rate of going of the watch has been more irregular than in some ordinary watches. When such a circumstance occurs, it is extremely unpleasant: the purchaser not understanding the difficulties

difficulties which the maker has to encounter, thinks himself ill used, and the latter suffers at the same time in his reputation as an artist; and in his character as a man; and when the watches happen to have been made for nautical purposes, or for exportation, the whole community, in some measure, become sufferers.

The intention of the present paper is to point out a defect in the construction of time-pieces of every description in which balances are used, and at the same time a source of error in their performance, which has been hitherto little if at all suspected, but which, where it occurs, completely defeats all the ends intended to be answered by the application of the above-mentioned ingenious contrivances: and that it does occur very frequently, will be made sufficiently obvious by a simple detail of facts supported by actual experiments.

That the balances of watches, when manufactured of steel, as they mostly are, might be in a small degree magnetic; and consequently have some influence in disturbing their vibrations; has been suspected by some and denied by others: but that a circular body, such as a balance is, should possess polarity; that a particular point in it should have so strong a tendency to the north, and an opposite point an equal tendency to the south, as to be sufficient materially to alter the rate of going of the machine when put in different positions, has never, I believe, been even suspected. If it had, the use of steel balances would have been laid aside long ago, particularly where accurate performance was indispensable, as in time-pieces for astronomical and nautical purposes. Though I have frequently examined, with great care, watches that did not perform well, even when no defect in their construction or finishing was apparent, and suspected the balance to be magnetic, yet I never could have imagined that this influence, operating as a cause, could produce so great an effect as I found upon actual experiment; for I did not expect to find that a balance, even when magnetic,

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should have distinct poles. Happening to have a watch in my possession, of excellent workmanship, but which performed the most irregularly of any watch I had ever seen; and having repeatedly examined every part with particular attention, without being able to discover any cause likely to produce such an effect, it put me upon examining whether the balance might not be magnetic enough to produce the irregularity observed in its rate of going.

I took the balance out of its situation in the watch, and, after removing the pendulum spring, put it into a poising tool, intending to approach it with a magnet, but at a considerable distance, to observe the effect, while at the same time the distance of the magnet should preclude the possibility of the magnetic virtue being thereby communicated to the balance. I had no sooner put it into the tool than I observed it much out of poise; that is, the one side appeared to be heavier than the other: but, as it had been before examined, in that particular, by a very careful workman, more than once, I was at a loss to determine what to think of the effect I saw; when happening to change the position of the tool upon the board, the balance then appeared to be in poise. As there could be no magic in the case, it appeared that the balance had magnetic polarity, as no other cause could produce the effect I had witnessed, and which was repeated as often as I chose to move the tool from the one position to the other. It happened that I was then sitting with my face to the south: a circumstance that led me, in placing the plane of the balance vertically, to put it north and south, and of course the axis east and west—the only position in which the magnetic influence could make itself most apparent, and which will account for the circumstance not having been observed by the workman who examined the poise of the balance before I did; for, as often as I placed the plane of the balance vertically between east and west it was in poise, whichever end of its axis was placed towards the south.

Having pretty well satisfied myself as to the cause, I now proceeded to determine the poles of the balance. With that view I placed its axis in a vertical situation, and of course its plane was horizontal; and I was much surprised to find that, in that position, it possessed sufficient polarity to overcome the friction upon its pivot; for it readily turned on its axis to place its north pole towards the north. Making a mark on that side that I might know its north pole, I then repeatedly turned that point towards the south; and, when left at liberty, it as often resumed its former position, performing a few vibrations before it quite settled itself in its situation and came to rest—exactly as a needle would do if suspended in the same manner.

I was extremely happy that I had observed these effects before I brought a magnet to make the experiment I first intended, as I might, and as others also might have concluded, that the polarity had been produced by the approach of the magnet. I now, however, brought a magnet into the shop, and, presenting its south pole to the marked side, that is, to the north pole of the balance; the balance continued at rest; but upon presenting the north pole to the marked place, it immediately receded from the magnet, and resumed its former position whenever the magnet was withdrawn.

No doubt now remaining as to the facts, and being in possession of the position of its poles, I proceeded to examine the effects produced by this cause upon the watch's rate of going. Having put on the pendulum spring, and replaced the balance in the watch, I laid the watch with the dial upwards, that is, with the plane of the balance horizontally, and in such a position that the balance when at its place of rest should have its marked side toward the north:—in this situation it gained 5' 35" in twenty-four hours. I then changed its position so that the marked side of the balance when at rest should be towards the south, and, observing its rate of going for the next twenty-four hours, found it had lost 6' 48"—producing, by its change of position only, a difference of

12' 23'' in its rate. It must be obvious to every person, that even this difference, great as it was, would be increased or diminished as the wearer should happen to carry in his waistcoat pocket a key, a knife, or other article made of steel. This circumstance, taken along with the amount of the variation occasioned by the polarity of the balance, was fully sufficient to produce all the irregularity observed in the going of the watch.

I then took away the steel balance, substituted one made of gold, and, having brought the watch to time, observed its rate of going, and found it as uniform as any watch of the like construction; for, though it was a duplex escapement, which is perhaps the best yet invented, at least for common purposes, it had no compensation for the expansion and contraction occasioned by heat and cold, and therefore a perfect performance was not expected.

Steel balances being commonly in use, and, on that account, easiest to be procured, and being on many accounts preferable to any other, I was unwilling to abandon them entirely; but resolved to take the precaution of always trying them before I should apply them to use. The mode I adopted was, to lay them upon a slice of cork sufficient to make them float upon water, and I was in hopes that out of a considerable number I might be able to select sufficient for my purpose; but to my surprise, out of many dozens which I tried in this manner, I could not select one that had not polarity. Some of them had it but in a weak degree, and not more than one or two, out of the whole quantity, appeared to have it so strong as the one which gave birth to these experiments and to the present paper, which is perhaps more prolix than could be wished: but the subject appeared to be not uninteresting, and I hope the remarks I have offered will not be altogether useless, as every thing that can tend to add to the perfection of time-pieces, or to remove any cause that operates against their perfection, is of some importance.

My only motive in sending this for publication in the
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Philosophical Magazine is to render some service to a science which I at first studied for amusement only, having never been instructed in any part of it, and for some years without the most distant idea of ever following it as a business. Should it prove acceptable, I may perhaps follow it up with a demonstration, and a few diagrams to illustrate the foregoing experiments, and to cast some light on other branches of this science; particularly on the various escapements now in use, and the advantages and disadvantages of their different constructions and applications in clock and watch work. In doing this a compensation for pendulums will be pointed out, simple and cheap in its construction, yet calculated to obviate the inconveniences attending the ingenious but expensive contrivances that have hitherto been resorted to, and at the same time capable of the nicest adjustment possible. This improvement, for such I consider it, will serve at the same time to shew how our very amusements, and the study of our leisure hours, when directed to useful objects, though with slender abilities and under many disadvantages, may eventually be of service to our friends in particular, and beneficial to society in general.

*Hatton-house,
May 31, 1798.*

S. VARLEY.

P. S. As I am persuaded a Journal carried on upon the plan you have proposed cannot fail to be useful to the community, and as even hints may sometimes pave the way to greater improvements, I shall look over my memorandums, from among which I may perhaps be able to furnish you with some, on a variety of subjects, for the amusement of your scientific readers.

V. *Method of preparing a cheap Substitute for Oil Paint, &c. durable as that prepared with Oil, and free from any bad Smell. By M. LUDICKE. From the Bibliotheque Physico-économique, 1792.*

IT often happens that people do not choose, or cannot employ oil-painting in the country, either because it does not dry soon enough and has an insupportable smell; or because it is too dear. M. Ludicke employed, with the greatest success, the following method for painting ceilings, gates, doors, and even furniture.

The Process.

Take fresh curds, and bruise the lumps on a grinding-stone or in an earthen pan or mortar with a spatula. After this operation, put them in a pot with an equal quantity of lime well quenched and become thick enough to be kneaded; stir this mixture well, without adding water, and you will soon obtain a white-coloured fluid, which may be applied with as much facility as varnish, and which dries very speedily. But it must be employed the same day, as it will become too thick the day following.

Ochre, Armenian bole, and all colours which hold with lime, may be mixed with it, according to the colour which you wish to give to the wood; but care must be taken that the addition of colour made to the first mixture of curds and lime may contain very little water, else the painting will be less durable.

When two coats of this paint have been laid on, it may be polished with a piece of woollen cloth or other proper substance, and it will become as bright as varnish. It is certain that no kind of painting can be so cheap: but it possesses, besides, other advantages: in the same day two coats may be laid on and polished, as it dries speedily and has no smell. If it be required to give it more durability, in places exposed

to moisture, do over the painting, after it has been polished, with the white of an egg: this process will render it as durable as the best oil painting.

VI. *On the Antiquity and Advantages of Encaustic Painting, with an Examination of the Process employed in that Art by the Ancients. From a Treatise entitled Antichita, Vantaggi e Metodo della Pittura Encausta; Memoria del Ch. Sig. Giov. Fabbroni, &c. Roma, 1797. Quarto.*

ITALY is much indebted to the penetration of the learned Abbé Requeno for again bringing forward to the notice of modern painters wax-painting, (*pittura encausta*;) which was forgotten, and considered as entirely lost.

The stimulus of curiosity always keeps alive and vigilant that laudable ambition to which we owe the most valuable discoveries; and writers are ever ready to catch the new idea, either to appropriate it to themselves, or at least to participate in the honour of it. By the collision of their various attacks on each other, truth is thrust forwards so as to be more distinctly seen than before, and the discovery thus acquires more value, and can be employed with more advantage.

No sooner had Requeno, whose merit entitles him to so much praise, made known the result of his researches, than a numerous body appeared to examine the advantages of it, or to share in the approbation bestowed on it. Some explained the classics in a manner different from what he had done, and others proposed methods which they considered as superior. Wax, in all probability, forms the only ground of encaustic painting. Requeno, from his own ideas, adds mastic; but Lorgna converts no less absolutely his wax into soap; as Bachelier does with the alkali of soda. The ingenious Astori, displeased with both their readings, wishes no

less absolutely to add gum and honey, as he affirms that it would render the wax far more yielding, and much softer for the brush.

I contented myself with considering, in my closet, the result of the laudable dispute of these able and meritorious writers, and thought I could clearly perceive that none of them had come near enough to the mark, though each of them had done essential service to the art.

Some of the ancient writers who have thrown light on this subject, among whom are Varro, Vitruvius, and Pliny, expressly ascribe to the ancient painters the use of Punic, that is Carthaginian, wax. It was said to be the best, as it exceeded in whiteness the Sardinian and Corsican; and the reason of this probably lay in its being better purified; for the Africans, as Pliny tells us, were accustomed to use alkali in order to render this substance whiter, and, in my opinion, to free it from all greasy matter. It was then called Punic wax, as Venetian turpentine, soap, and wax, are now prescribed in books of receipts in order to signify the best; and we must conclude, if, instead of considering the wax to have been merely bleached, we convert it into real soap, arising from the close combination of the wax with the alkali, that we change and pervert the meaning of these authors. The idea which I formed of the period of encaustic painting, and the country where invented, was considerably different, and I have had the pleasure of finding it afterwards confirmed by experiments and facts.

The knowledge and use of encaustic painting is certainly older than the time of the Greeks and the Romans, to whom the learned Requeno seems to assign the exclusive possession of this art; because the Egyptians, who with the Etruscans were the parents of the greater part of the inventions known among mankind, and from whom the Greeks learned so much, were acquainted with and employed encaustic painting in the ancient ages of their greatness and splendour, as is proved by the valuable fragments of the bandages and coverings

coverings of a mummy painted in this manner, which, by the favour of our gracious prince, the noble patron and promoter of the arts and sciences, is exposed to the view of every connoisseur, in his elegant museum. The existence of wax on this Egyptian mummy may be discovered on a bare view; but I convinced myself by other proofs of a less dubious nature.

Most of the mummies, however, preserved in collections, are painted with a size, which appears to be not unlike that used in paintings with water colours (*pittura a tempera*); but it is certain that the Egyptians differed much in their ornaments, and the bandages of the mummy above-mentioned are, on this account, more valuable and more worthy of notice.

I saw in the British Museum a mummy which was entirely covered with glassy grains; and the colour of some of them gave me reason to conjecture that these ancient people were acquainted with the effects of cobalt in finalt, which has however been considered as a new invention. I saw another mummy at Paris, which had formerly belonged to the celebrated Count Caylus: among other singularities it had some ornaments of leaf gold upon a ground of chalk and bolus, which is at present employed by the European gilders. In the Royal Museum at Florence there is, besides others, one with gilding of the like kind and very lively colours. But I will not here enter into a panegyric of the Egyptians, who accomplished so great things, and much earlier than the Greeks or the Romans; it will be sufficient to have shewn, as a point unknown in the history of the arts, that these people practised encaustic painting, as appears beyond a doubt from the before-mentioned fragment: but I will confess that this would be a barren knowledge if it did not lead us to other useful researches. I must observe, in the first place, that no oil-painting, perhaps of only two or three hundred years old, exhibits a white paint that has kept so well as that seen on the above fragment; and this circumstance sufficiently proves
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the valuable advantage that method has over the common oil-painting, which, notwithstanding the general opinion, cannot have been unknown to the ancients; for, besides olive-oil, they were acquainted with that of sesamum, turpentine, cedar, and nut oils. It is impossible that in Egypt and Phœnicia, where so much use was made of flax, the oil procured in abundance from that plant should have been unknown. Those who have kept oil, or who have spilt any of it, whether nut or lintseed oil, must have remarked that it possesses the property of soon drying by the effects of the atmosphere; and therefore it may be easily believed that mankind must soon have conceived the idea of employing it, particularly for ships, which, as Herodotus says, were painted with red ochre in the earliest periods, and adorned with figures and ornaments. The use of oil afforded painting a much simpler and easier method than that of wax; it must therefore have been first adopted, and the transition from oil to wax must be considered as a step towards bringing the art to perfection; because encaustic painting is not exposed to the irremediable inconveniencies that arise in oil-painting, the value of which we extolled through ignorance, and praised as a new invention.

Oil in general, and in particular drying oil which the painters use, has naturally a strong inclination to combine itself with the vital air or oxygen of the atmosphere, and by imbibing oxygen it becomes dry, and assumes the character of resin; but the colour then becomes darker, as is the case with transparent turpentine, which gradually becomes a black pitch.

According to the new and more accurate method of decomposing bodies, oil consists principally of hydrogen and carbon. By coming into contact with the atmosphere, and absorbing its oxygen and light, it undergoes a slow and imperceptible combustion, which is not essentially different from the speedy and violent which it would undergo in the common mode of burning. It first passes, by imbibing oxygen,

gen, into the state of a more or less dark resin; loses gradually its essential hydrogen, which makes a new combination, and afterwards the oxygen itself which has attracted the carbon; and at length leaves behind a thin layer of actual carbon, which in the end becomes black in the course of time, and considerably obscures the oil-painting. By a continuance of the before-mentioned slow combustion the carbon itself, as it were, burns also; if it be strongly acted upon by the light, it attracts the oxygen of the atmosphere, and again brings forward the carbonic acid or fixed air, which gradually flies off. By this, which I may call the second degree of combustion, the painting must become dusty and friable, like crayon painting (*il pastello*); a phenomenon which may be clearly perceived on oil-paintings, which are generally covered with wood and iron-work, that they may the better withstand the atmosphere.

The ashes, oxydes, or calces of metals, which are often used as paints, are nothing else than metals actually brought to a burnt or saline state by different doses of oxygen. When the oil, during the time of the before-mentioned combustion, deprives them of some part of their oxygen by means of its well-known affinity, the metal again proportionably assumes its natural state and colour; and as the calces or ashes of the iron, and particularly white lead, return to their former metallic character, they become, in various ways, black, by the loss of the oxygen, which, as is well known, is drawn from them merely by the contact of the light, especially when strong.

It appears from the preceding theoretical observations, that one can hope only for a transient or deceitful effect from the refreshing of oil-paintings with oil, because the harmony of the tones, which the painter establishes as suited for the moment, does not proceed with equal steps, and cannot preserve itself in the like measure for the course of a few years, as each tint, as they say, ought to increase, or, to speak more properly, to burn in proportion to its antiquity. It thence follows, that
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mere washing may be prejudicial to an old painting ; and that the method of refreshing paintings, as it is called, by daubing over the surface from time to time with new drying oil, is highly prejudicial and ill calculated for the intended purpose, since the oil when it becomes dry contracts in its whole surface, carries with it the paint under it, and occasions cracks in the painting. New oil of this kind gives occasion to mineral paints to be restored ; but covers the picture with a new coat of resin, and then of carbon, which arises from the gradual combustion, and always causes more blackness, and the decay of the painting which one wishes to preserve. Wax, on the other hand, undergoes a change which is very different from that of drying oil. The wax, instead of becoming black by the contact of the atmosphere, increases in whiteness, and, according to its natural quality, is not decomposed in the air, and it does not strongly attract the oxygen of the calces or metallic ashes which are commonly used in painting. Moreover, the so called earths, which are in themselves white, and are never variable either by the presence or absence of oxygen, cannot be employed in oil-painting, because that fluid makes them almost transparent, and causes them to remain as it were without body (*corpo*), and not to produce the wished-for effect. That beautiful white, which may be observed on the before-mentioned Egyptian encaustic, is nothing else than a simple earth, and according to my chemical experiments a chalk (*creta*), which is also unalterable. If we consider this encaustic fragment as belonging to the epoch of the first violent change which the religious system of the Egyptians experienced, it will be a specimen of painting of about 2500 years old ; for such is the number of the years that have elapsed since Cambyfes overturned the ceremonies and religious worship of the Egyptians, not only by the sword, but by the still more powerful weapons of ridicule. Dead bodies were embalmed there in the time of Herodotus ; but the cloth in which they were wrapped, or the bandages bound round them, were no longer painted

painted with sacred characters. The bodies were only inclosed in wooden cases, which were more or less ornamented. Many are of opinion, that an expression of the bishop of Hippo gives reason to assert that the people in Egypt continued to prepare mummies even till the fifth century; but it must be observed that the Egyptians then had adopted the Christian religion; that they no longer used hieroglyphical inscriptions, which in the time of Apuleius were said to be unintelligible and forgotten; and that it was not mummies which were prepared then, but *gabbara*, as St. Augustine says in his Oration, that is, dead bodies dried after the manner of mummies. If Bochart and Menage be not mistaken, the name *mumia* is derived from *mum*, which signifies wax: and one might therefore believe that the dress of embalmed bodies was thus named because wax was employed for painting it; and thence it would follow, that the fragment in question may be classed among the oldest.

Mummies, since the earliest periods of the Egyptian ceremonies, were exposed to a variety of situations; for on certain occasions they were taken up from the subterranean repositories in which they were deposited, and placed in the highways, or at the doors of the houses. On other occasions they were carried into the halls where entertainments were celebrated, and they were also given as pledges of fidelity in various transactions.

After the fall of Egyptian grandeur, the mummies were left buried and neglected in dark vaults, amidst a damp soil, from which they were drawn forth only at a late period, by European curiosity, in order to ornament collections, or by the avarice of the Mahometans, who hoped to make them an article of gain.

Many have remarked, and in particular Maillet during his consulship at Cairo, that the Arabs, when they find mummies of good appearance, usually cut them to pieces, in order to examine whether any thing of value is concealed in their clothing.

clothing. I can assign no other cause for the fragment in question; and this would enhance the value of it, and render more important, as well as more useful, its great antiquity; and the beautiful painting to be seen on it.

In all probability the ancients, as I have already said, were once acquainted with the use of oil-painting, and lost or neglected it afterwards, so that it was perhaps employed only sometimes by a few.

Petronius praises the fresh appearance which the valuable works of Zeuxis and Apelles had, even in his time; but Cicero, on the other hand, speaks of the paintings of the ancients having suffered from blackness. The former speaks of wax-painting, and the latter certainly alludes to paintings in oil. It is well known that paintings with wet chalks or water colours do not become black by age, and that this is the case also with encaustic. Of this any one may be convinced, not only by the expressions of the above quoted authors, but by one's own eyes on surveying the Egyptian fragment alluded to. Galland proves, on various grounds, that a painting was made with oil so early as the reign of Marcus Aurelius; and if no specimens of that period have reached us, this is perhaps to be ascribed to the frail and perishable nature of this species of painting.

The oldest oil-painting now in existence, as far as I know, is a Madonna and child on her arm with an eastern countenance. It has marked on it the date, which is thus expressed *ccccclxxxvj*. If we express these with Arabic characters, it would make, in my opinion, 886, and the period of this piece would fall about the time of Basilus or Charlemagne. This singular and valuable painting, found in the old palace (*palazzo vecchio*) of the Florentine republic, is preserved at present in the chapel of the noble and learned director Ben-
civenni otherwise Pelli, who purchased it of a broker in the street for a few livres. I must however remark, that if instead of the above date we ought to read *mccccclxxxvi*,
which

which appears to me probable, it would still be one of the oldest of its kind in Italy, and belong to the oil-paintings of the fourteenth century, some of which are mentioned by Dominici and Tiraboschi prior to the discovery of the celebrated Van Eyck.

(To be concluded in the next Number.)

VII. *Method of discovering whether Wine has been adulterated with any Metals prejudicial to the Health.* By M. HANHEMANN. From *Bibliothèque Physico-économique*.

THE property which liver of sulphur (alkaline sulphures) and hepatic air (sulphurated hydrogen) possess of precipitating lead in a black form, has been long ago made public; and this property has been employed to determine the quality of wines by means of the *liquor probatorius Wirtembergensis*, or Wirtemberg proving liquor.

But, in trying wines supposed to have been adulterated, this proof does more hurt than service, because it precipitates iron of the same colour as the pernicious lead. Many wine-merchants therefore of the greatest respectability, rendered by these means suspected, have been ruined.

There was wanting then a re-agent, which should discover in wine those metals only which are prejudicial to the health of man.

The following liquor precipitates lead and copper in a black form, and arsenic of an orange colour, &c. but does not precipitate iron. The last, which is not noxious, and rather salutary to the constitution, frequently gets into wines by accident.

Method of preparing the Proving Liquor.

Mix equal parts of oyster shells and crude sulphur in a fine powder, and put the mixture into a crucible. Heat it
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in a wind furnace, and increase the fire suddenly, so as to bring the crucible to a white heat, for the space of fifteen minutes. Pulverise the mass when it is cool, and preserve it in a bottle closely stopped.

To prepare the liquor, put 120 grains of this powder and 120 grains of cream of tartar (acidulous tartarite of potash) into a strong bottle; fill the bottle with common water, which boil for an hour, and then let it cool; close the bottle immediately, and shake it for some time: after it has remained at rest to settle, decant the pure liquor, and pour it into small phials capable of holding about an ounce each, first putting into each of them 20 drops of muriatic acid. They must be stopped very closely with a piece of wax, in which there is a small mixture of turpentine.

One part of this liquor mixed with three parts of suspected wine, will discover, by a very sensible black precipitate, the least traces of lead, copper, &c. but will produce no effect upon iron, if it contains any of that metal. When the precipitate has fallen down, it may still be discovered whether the wine contains iron, by saturating the decanted liquor with a little salt of tartar (tartarous acidulum of potash), by which the liquor will immediately become black.

Pure wines remain clear and bright after this liquor has been added to them.

VIII. *On the Solar and Lunar Period of Six Hundred Years.*

By Professor BURJA, Member of the Royal Academy of Sciences at Berlin. Extracted from a Paper read on the 13th of December 1792.

THE historian Josephus says that God prolonged the lives of the patriarchs to at least six hundred years, that they might become more perfect in the knowledge of astronomy, because

because the great year is always completed at the end of that period.

No other ancient writer, however, makes any mention of this great year; but Pliny in his *Natural History* relates, that Hipparchus had fixed the course of the sun and moon at six hundred years; which seems to refer to a period of that duration: and it is to be conjectured, that it was established by the ancients in order to compare the course of the moon with that of the sun, and to foretel for a considerable time beforehand the phases of the moon.

This, indeed, was one of the principal objects of the ancient astronomy. Meto invented the period of nineteen years, because he believed that nineteen tropical solar years made exactly 235 lunar months. Calippus quadrupled this period, and made a new one of 76 years. Hipparchus quadrupled these 76 years, and by these means obtained a more accurate period of 304 years.

Now it may be readily supposed, that Hipparchus, in the hopes of deviating still less from the truth, at length doubled his period, and brought it to 608 years; for, otherwise, why should he have fixed his period even at 600 years?

According to every conjecture, the great year is nothing else than the last doubled period of Hipparchus; for, though Pliny and his cotemporary Josephus speak in round numbers of 600 years, or six centuries, yet we know that mathematical accuracy is not always observed in the language of common life and of historians.

Mr. Bailly explains the period of six hundred years in a manner totally different. That astronomer finds, like all those conversant with the subject, that 600 solar years form no whole number of lunar months without a fraction: but as that would be the case if the year were assumed a little longer, as it really is, he thence concludes that the year in ancient times was actually so long as the precision of the period of 600 years requires; and besides, that those ages

produced very able and expert astronomers, who discovered this period by an astonishingly long series of observations. In this manner every period, however assumed at pleasure, might be justified. It would be only necessary to reckon what length of year it would require ; to assume a certain acceleration in the revolution of the earth ; to determine thereby at what time the year had the requisite length ; and then to be astonished how accurate mankind were in their astronomical calculations at that period.

The reader may determine between both these explanations. It might still be supposed, that the ancients really had a period of exactly 600 years, neither more nor less, and that they deduced it from a false determination of the length of the year. But this would not agree well with the rest of their known periods.

IX. *On the Irritability of Sea Sponges. From Neue Nordische Beyträge, by Professor PALLAS.*

I HAVE for a long time remarked in different kinds of sponge (*spongiæ*), particularly the *spongia villosa*, and all tough sea sponges, and even the commonest sponge employed in bathing-houses, when not too much used, certain remains of irritability, which, in these bodies kept so long out of their own element, cannot be considered but as mechanical. If the above sponges be soaked in cold water until they extend to their full magnitude, and hot water be poured over a part, or the whole of them, they instantaneously contract themselves, particularly in the irritated part, with a wonderful velocity and force, as if alive. As soon, however, as the irritation of the heat ceases, they again extend to their former size. This experiment may be repeated with a sponge, until its whole consistence and texture are destroyed by the hot water. An accidental observation made

on a tubular piece of the before-mentioned *spongia villosa* first induced me to repeat the same experiment on other kinds of tough sea sponges.

X. *On the Theory of the Structure of Crystals.*

[*With a Plate, No. II.*]

WHEN we reflect on the rapid progress which has been of late made in most branches of natural knowledge, and particularly in chemistry and mineralogy, and consider how much these may be facilitated by a competent knowledge of those regular forms which all mineral and saline substances assume, in certain circumstances; it appears surprising, that, though we have a number of books which treat on chemistry, we have not one English work on the theory of the structure of crystals. To remedy this defect in some degree, and as an introduction to original papers on the subject promised to us by an eminent mineralogist, we think proper to lay before our readers the following translation of

*The Abbé HAUR's Theory of Crystallization. From
Vol. XVII. of the Annales de Chimie.*

I GAVE in this Journal, some years ago, a short account of the theory of crystallization; but that paper may be considered only as a short sketch, and more calculated for those who wish not to be entirely ignorant of the subject, than for those desirous of becoming thoroughly acquainted with its principles and results. In the present paper I propose to afford the latter an opportunity of obtaining their object, by presenting them with the theory required, and with all the facts necessary to give them a just idea of the laws to which it is subject, and of the progress by which it has been carried to such a degree of generality, that an im-

menſe number of facts, formerly unconnected, now become arranged, as if of themſelves, around a ſingle one on which they depend, and which ſerves to connect them all by mutual relations.

I confeſs, however, that this theory can be well underſtood only by the help of analytical calculations *. Beſides the advantage which analysis has of involving in the ſame formula the ſolutions of an infinite number of different problems, it alone can give to the theory the character of abſolute certainty, by producing reſults perfectly agreeable to thoſe we receive from obſervation.

Notwithſtanding theſe conſiderations, I thought it would be better for thoſe unacquainted with the ſcience of calculation, if I adhered to ſimple reaſoning, accompanied by geometrical figures, which are ſo uſeful in aſſiſting the imagination to conceive the arrangement of thoſe ſmall ſolids that concur to form a crystal, but which were wanting to the firſt paper.

This arrangement I call *ſtructure*, as oppoſed to the term *organization*, which expreſſes the far more compound mechanism of animals and plants.

If this procedure be leſs direct, leſs expeditious, and leſs precise; and if it requires us to attend to thoſe details which algebra paſſes over in order to conduct us ſpeedily to its object, it is at leaſt attended with this advantage, that the mind by its means perceives better the connexion of the different parts of the whole under its conſideration.

I. Mechanical Diviſion of Crystals.

It is known that the ſame mineral ſubſtance is ſuſceptible of many different forms well defined, ſome of which do not preſent, on the firſt view, any common point of reſemblance that ſeems to indicate their relation. If we compare, for example, calcareous ſpar in a regular hexaedral priſm with

* See Memoires de l'Acad. des Sciences, An 1790.

the rhomboid * of the same spar whose large angle is about $101\frac{1}{2}^{\circ}$, we shall, at first, be inclined to believe that each of these two forms is entirely foreign to the other. But that point of union which escapes our notice, when we confine ourselves to the consideration of the exterior form, becomes sensible when we penetrate into the internal mechanism of the structure. Let me here then be permitted to trace things from their origin, by relating how the observation from which I set out, and which has become the key of the whole theory, first presented itself to my mind.

I was holding in my hand a hexaedral prism of calcareous spar, similar to the one I have mentioned, and which had fallen from a group of which it formed a part. The fracture presented a very smooth surface, situated obliquely, like the trapezium $p s u t$ (fig. 1), and which made an angle of 135° , both with the residue $a b c f p b$ of the base, and with the remainder $t u e f$ of the plane $i n e f$. Observing that the cuneiform segment $p s u t i n$ separated by this fracture from the crystal had for vertex one of the edges of the base, that is to say the edge $i n$, I wished to know if I could detach a second segment in the part to which the next edge $c n$ belonged, by employing for that purpose the blade of a knife

* I give the name of rhomboid to a parallelopipedon ae (fig. 4) terminated by six rhombuses equal and similar. In every rhomboid two of the solid angles such as a, e , opposite to each other, are formed by the junction of three equal plane angles. Each of the other six solid angles is formed by a plane angle equal to each of the preceding, and by two other angles of a different measure, but equal to each other. The points a, e , are the summits, and the line ae the axis. In any one whatever $abdf$ of the rhombuses, which compose the surface, the angle a , contiguous to the summit, is called the *superior angle*; the angle d the *inferior angle*; and the angles b and f are the *lateral angles*. The sides ab, af , are the *superior edges*; and the sides bd, df , the *inferior edges*; bf is the *horizontal diagonal*; and ad the *oblique diagonal*. The rhomboid is obtuse or acute according as the angles of the summits are obtuse or acute. The cube is the boundary of the rhomboids.

directed in the same degree of obliquity as the trapezium *p s u t*, and assisted by the strokes of a hammer. This attempt was fruitless; but having tried the same operation towards the following edge *b c*, I uncovered a new trapezium similar to the first. The fourth edge *a b* resisted the instrument like the second; but the next one *a b* yielded easily to the mechanical division, and presented a third trapezium of as fine a polish as the other two. It is almost unnecessary to add, that the sixth edge *i h* remained indivisible, like the fourth and the second.

I then proceeded to the inferior base *d e f g k r*, and observation proved to me that the edges of this base, which admitted sections like the preceding, were not the edges *ef*, *dr*, *gk*, corresponding with those I had found divisible towards the upper part, but the intermediate edges *de*, *vy*, *gf*. The trapezium *l q y v* represents the section made below the edge *kr*. This section is evidently parallel to that of the trapezium *p s u t*, and in the like manner the four other trapeziums are parallel two to two. But these different sections being in the direction of the natural joining of the laminæ, I easily succeeded to obtain more sections parallel to each of them, while it was impossible to divide the crystal in any other direction. By continuing this mechanical division, determined by the parallelism above mentioned, I came to new sections, always nearer the axis of the prism; and when these sections had made the remainders of the two bases to disappear, the prism was transformed into the solid *OX* (*fig. 2*) terminated by twelve pentagons, parallel two to two, of which those at the extremities *SAOIR*, *GIODE*, *BAODC*, on the one side, and *KNPQF*, *MNPXU*, *ZQPXY*, on the other, were the results of the mechanical division, and had their common vertices *O*, *P*, situated in the centres of the bases of the prism (*fig. 1*). The six lateral pentagons *RSUXY*, *ZYRIG*, &c. (*fig. 2*) were the remains of the planes of the same prism.

In proportion as I multiplied the sections, always parallel to the preceding, the lateral pentagons decreased in height; and

and at a certain term the points RG becoming confounded with the points YZ, the points SR with the points UY, &c. there remained nothing of the pentagons in question but the triangles YIZ, UXY, &c. (fig. 3). Beyond that term the sections happening to pass over the surface of these triangles diminished gradually their extent, until, at length, these triangles were lost; and then the solid which arose from the hexaedral prism became a rhomboid $a e$ (fig. 4) entirely like that commonly distinguished under the name of Icelandic spar.

A result so unexpected made me immediately conceive the idea of subjecting the other calcareous crystals to the same proof; and all yielded to the mechanical division in such a manner, that, when the external faces had disappeared, the kind of nucleus which remained under the instrument was still a rhomboid of the same form as the first. The only thing necessary was to find the direction of the sections which conducted to the central rhomboid.

To extract, for example, this rhomboid from that spar called commonly the *lenticular*, and which is a much more obtuse rhomboid, having its great plane angle equal to $114^{\circ} 18' 56''$, it was necessary to begin at the two vertices, making the sections pass through the lesser diagonals of the faces. If it were wished, on the contrary, to get at the nucleus of the rhomboidal spar with acute vertices*, it would be necessary to direct the sections of the planes parallel to the edges adjacent to the vertices, and in such a manner that each of them should be equally inclined to the planes it cuts.

These results are the more worthy of attention, as it would at first seem that crystallization, after having once adopted the rhomboid, in regard to one determined species of mineral, ought always to re-produce it with the same angles. But

* This rhomboid, as well as the preceding, will be farther explained in the course of the present article.

the paradox arising from this diversity of appearance is explained by the double use of the rhomboidal form, which serves here to disguise itself, and which conceals fixed and constant characterising marks under a variable outside.

If we take a crystal of another nature, such as a cube of fluor spar, the nucleus will have a different form. This, in the present case, will be an octaedron, to which we shall arrive by taking off the eight solid angles of the cube. Heavy spar will produce, for nucleus, a right prism, with rhomboidal bases; feld spar an oblique-angled parallelopipedon, but not rhomboidal*; the apatite or beryl a right hexaedral prism; the adamantine spar a rhomboid, a little sharpened; blend a dodecaedron, with rhomboidal planes; iron of the island of Elba, a cube, &c. and each of these forms will be constant in regard to the whole species, so that its angles will undergo no variation of importance; and if an attempt be made to divide the crystal in any other direction, we shall not be able to find a joining. Nothing will be obtained but undefined fragments: in a word, it will be broken rather than divided.

These solids, inscribed, each, in all the solids of the same species, ought to be considered as the real primitive forms on which all the other forms depend. All minerals, I confess, are not susceptible of being divided mechanically, but there are a greater number than I at first thought; and with regard to those crystals which have hitherto resisted my efforts to find their natural joinings, I have remarked that their surface, striated in a certain direction, or the relation of their different forms among those which belong to the same substance, often present indications of their structure; and that, reasoning from their analogy with other divisible crystals, we may determine that structure at least with great probability.

I call *secondary forms* all those that differ from the primitive form. We shall see, hereafter, that the number of these

* Mem. de l'Acad. des Sciences, An 1784, p. 237.

forms has limits, which can be determined by theory, according to the laws to which the structure of crystals is subjected.

The solid of the primitive form, obtained by means of the operation above explained, may be subdivided in a direction parallel to its different faces : all the enveloping matter is equally divisible by sections parallel to the faces of the primitive form. It thence follows that the parts detached by the help of all these sections are similar, and differ only in their bulk, which continues to decrease in proportion as the division is carried still farther. We, however, must except those which are near to the faces of the secondary solid ; for, these faces not being parallel to those of the primitive form, the fragments which have one of their facets taken in the same faces cannot entirely resemble those detached towards the middle of the crystal. For example, the fragments of the hexaedral prism (fig. 1), the external facets of which make part of the bases or of the planes, have not, in that respect, the same figure as those situated nearer the centre, and of which the facets are all parallel to the sections *p s u t*, *l q y v*, &c. But theory, as I shall shew, removes all the embarrassment which, on the first view, arises from that diversity, and reduces the whole to an unity of figure.

But the division of the crystal into small similar solids has a term beyond which we should come to particles so small, that they could no longer be divided without analysing them; that is to say, without destroying the nature of the substance. I stop at that term ; and I give to the corpuscula we should insulate, if our organs and instruments were sufficiently delicate, the name of *integral molecule*. It is very probable that these *molecule* are those which were suspended in the fluid in which the crystallization was effected. But my readers may judge for themselves. We may, however, with truth, assert, that, by the assistance of these *molecule*, theory reduces to simple laws the different metamorphoses of crystals,

crystals, and arrives at results which exactly represent those of nature; and this is the only end I proposed.

When the nucleus is a parallelepipedon, that is to say, a solid with six parallel faces, two to two, like the cube, the rhomboid, &c. and this solid does not admit of any other divisions than those made in the direction of the faces, it is evident that the molecule resulting from subdivision, both of the nucleus and of the enveloping matter, are similar to the nucleus. In other cases the form of the molecule differs from that of the nucleus. There are also crystals which, by help of the mechanical division, yield particles of different figures, combined together throughout the whole extent of these crystals. I shall explain hereafter my conjectures on the manner of resolving the difficulty presented by these kinds of mixed structures; and it will be seen that this difficulty does not affect the theory at bottom.

II. *Laws of Diminution.*

1. Diminution at the edges.

The primitive form and that of the integral molecule being determined, after the dissection of the crystals, it was necessary to discover the laws according to which these molecule were combined to produce, around the primitive form, those species of envelopes, terminated so regularly, and from which resulted polyhedra so different from each other; though originally of the same substance. But such is the mechanism of the structure subject to these laws, that all the parts of the secondary crystal, superadded to the nucleus, are formed of laminae, decreasing regularly by the subtraction of one or more ranges of integral molecule; so that theory determines the number of these ranges, and, by a necessary consequence, the exact form of the secondary crystal.

To give an idea of these laws, I shall first make choice of a very simple and very elementary example. Let us conceive

EP (*fig. 5*) to represent a dodecaedron, whose faces are equal and similar rhombuses; and that this dodecaedron is a secondary form, which has a cube for its nucleus or primitive form. The position of this cube may be easily conceived by inspecting *fig. 6*, where it is seen that the small diagonals DC, CG, GF, FD, of the four faces of the dodecaedron, united around the same solid angle L, form a square, CDFG. But there are six solid angles composed of the four planes, viz. the angles L, O, E, N, R, P, (*fig. 5*); and, consequently, if sections are made to pass through the small diagonals of the faces which concur to the formation of these solid angles, we shall successively uncover six squares, which will be the faces of the primitive cube, and three of which are represented (*fig. 6*), viz. CDFG, ABCD, BCGH.

This cube would evidently be an assemblage of integral cubic molecularæ, and it would be necessary that each of the pyramids, such as LDCGF (*fig. 6*), which rest on the faces, should itself be composed of cubes equal to each other, and to those forming the nucleus.

To make it more apparent how this might take place, I shall point out the means of making an artificial dodecaedron, by employing a certain number of small cubes, the assortment of which will be an imitation of that of the molecularæ employed by nature in the formation of the dodecaedron we are here considering.

Let ABGF (*fig. 7*) be a cube composed of 729 small cubes equal to one another, in which case each face of the whole cube will contain 81 squares, nine on each side, which will be the external faces of as many partial cubes, representatives of molecularæ. The cube in question will be the nucleus of the dodecaedron which we propose to construct.

On one of the faces, such as ABCD of this cube, let us apply a square lamina composed of cubes equal to those which form the nucleus, but which towards each edge has a range of cubes less than if it had been on a level with the adjacent faces BCGH, DCGF, &c. That is to say, let this
lamina

lamina be composed only of 49 cubes, 7 on each side, in such a manner that if its inferior base be $o n f g$ (*fig. 8*), that base may fall exactly on the square marked by the same letters (*fig. 7*).

Above this first lamina let us apply a second composed of 25 cubes, five on each side, so that if $l m p u$ (*fig. 9*), represent its lower base, this base may be found situated exactly above the square designed by the same letters (*fig. 7*).

Let us, in like manner, apply a third lamina upon the second; but containing only 9 cubes, three on each side, so that $v x y z$ (*fig. 10*) being the inferior base, this base may correspond with the square marked by the same letters (*fig. 7*). Lastly, on the middle square r , in the preceding lamina, let us place the small cube r (*fig. 11*), which will represent the last.

It may be easily seen that by this operation we shall have formed upon the face ABCD (*fig. 7*) a quadrangular pyramid, of which this face will be the base, and which will have the cube r (*fig. 11*) for its summit. If we continue the same operation on the other five faces of the cube (*fig. 7*) we shall have, in all, six quadrangular pyramids, resting on the six faces of the nucleus, which they will envelop on all sides. But as the different courses or laminæ which compose these pyramids project beyond each other a certain quantity, as may be seen *fig. 12*, where the parts elevated above the planes BCD, BCG represent the two pyramids which rest on the faces ABCD, BCGH (*fig. 7*), the faces of the pyramids will not form continued planes: they will be alternately re-entering and salient; and in some measure will imitate a pyramidal ascent of steps, which presents four faces (*escalier à quatre faces*).

Let us now suppose that the nucleus is composed of an incomparably larger number of cubes, almost imperceptible; and that the laminæ, applied on the different faces, which I shall in future call *laminæ of superposition*, go on increasing towards their four edges, by subtractions of one range of cubes

cubes equal to those of the nucleus, the number of these laminæ will be found incomparably greater than in the preceding hypothesis; at the same time the cavities (*cannelures*) which they will form, by the alternate falling and re-entering of their edges, will be scarcely sensible; and we may even suppose the composing cubes so small that these cavities will become imperceptible to our senses, and that the faces of the pyramids will appear perfectly smooth.

Now DCBE (*fig. 12*) being the pyramid resting on the face ABCD (*fig. 7*), and CBOG (*fig. 12*) the pyramid applied on the neighbouring face BCGH, (*fig. 7*), if we consider that every thing is uniform from E to O (*fig. 12*) in the manner in which the edges of the laminæ of superposition mutually project beyond each other, it will readily be conceived that the face CEB of the first pyramid ought to be found exactly in the same plane as the face COB of the adjacent pyramid, so that the assemblage of these two faces will form a rhombus ECOB. But for the six pyramids we had twenty-four triangles, similar to CEB, which, consequently, will be reduced to twelve rhombuses, from which will result a dodecaedron similar to that represented (*fig. 5 and 6*); and thus the problem is resolved.

The cube, before it arrives at the form of the dodecaedron, passes through a multitude of intermediate modifications, one of which is represented *fig. 13*. It may be there seen that the squares *p a e o*, *k l q u*, *m n t s*, &c. correspond to the squares ABCD, DCGF, CBHG, &c. (*fig. 6*) and form the superior bases of as many pyramids, incomplete for want of the laminæ by which they ought to be terminated. The rhombuses EDLC, ECOB, &c. (*fig. 5*), by a necessary consequence are reduced to simple hexagons *a e C l k D*, *e o B n m C*, &c. (*fig. 13*) and the surface of the secondary crystal is composed of twelve of those hexagons and six squares. This is the case with the boracic spar, allowance being made for some facets which take the place

place of the solid angles, and which are subject to another law of decrease, to be spoken of hereafter.

If the decrease of the laminæ of superposition took place according to a more rapid law; if each lamina for example had had on its circumference two, three, or four ranges of cubes less than the inferior range, the pyramids produced around the nucleus, by this decrease, being more lowered, and their adjacent faces being no longer on a level, the surface of the secondary solid would be composed of 24 isosceles triangles, all inclined one to the other. I call *decrease on the edges* that which takes place parallel to the edges of the nucleus, as in the preceding examples, to distinguish it from another kind of decrease which I shall speak of hereafter, and which takes place according to directions altogether different.

(*To be continued.*)

XI. *Observations on Iron and Steel.* By JOSEPH COLLIER.
From the Transactions of the Manchester Society.

[*With a Plate, No. III.*]

AFTER examining the works of different authors who have written on the subject of making iron and steel, I am persuaded that the accounts given by them of the necessary processes and operations are extremely imperfect. Chemists have examined and described the various compound minerals containing iron with great accuracy, but have been less attentive to their reduction. This observation more particularly applies to steel, of the making of which I have not seen any correct account. It is singular to observe how very imperfectly the cementation of iron has been described by men of great eminence in the science of chemistry. Fourcroy states the length of time necessary for the cementation
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of iron to be about twelve hours; but it is difficult to discover whether he alludes to cast or to bar steel: for he says, that short bars of iron are to be put into an earthen box with a cement, and closed up. Now steel is made from bars of iron of the usual length and thickness: but cast steel is made according to the process described by Fourcroy, with this essential difference—the operation is begun upon bar steel, and not bar iron.

Mr. Nicholson is equally unfortunate in the account given in his *Chemical Dictionary*. He says that the usual time required for the cementation of iron is from 6 to 10 hours, and cautions us against continuing the cementation too long; whereas the operation, from the beginning to the end, requires 16 days at least. In other parts of the operation he is equally defective, confounding the making of bar with that of cast steel, and not fully describing either. In speaking of the uses of steel, or rather of what constitutes its superiority, Mr. Nicholson is also deficient. He observes that “its most useful and advantageous property is that of becoming extremely hard when plunged into water.” He has here forgotten every thing respecting the temper and tempering of steel instruments, of which, however, he takes some notice in the same page. “Plunging into water” requires a little explanation: for, if very hot steel be immersed in cold water without great caution, it will crack, nay sometimes break to pieces. It is however necessary to be done, in order to prevent the steel from growing soft, and returning to the state of malleable iron; for, were it permitted to cool in the open air, the carbon which it holds in combination would be dissipated*. I shall at present confine my remarks to the operations performed on iron in Sheffield and its neighbourhood, from whence various communications have been transmitted to me by resident friends, and where I have myself seen the operations repeatedly performed. The iron

* It is the opinion of some metallurgists, that a partial abstraction of oxygen takes place, by plunging hot metal into cold water.

made in that part of Yorkshire is procured from ores found in the neighbourhood, which are of the argillaceous kind, but intermixed with a large proportion of foreign matter. These, however, are frequently combined with richer ores from Cumberland and other places. The ore is first roasted with cinders for three days in the open air, in order to expel the sulphureous or arsenical parts, and afterwards taken to the furnaces, some of which are constructed so that their internal cavity has the form of two four-sided pyramids joined base to base; but those most commonly used are of a conical form, from forty to fifty feet high. The furnace is charged at the top with equal parts of coal-cinder and lime-stone. The lime-stone acts as a flux, at the same time that it supplies a sufficient quantity of earthy matter, to be converted into scoriæ, which are necessary to defend the reduced metal from calcination, when it comes near the lower part of the furnace. The fire is lighted at the bottom; and the heat is excited by means of two pair of large bellows blowing alternately. The quantity of air generally thrown into the furnace is from 1000 to 1200 square feet in a minute. The air passes through a pipe, the diameter of which is from two inches and a quarter to two and three quarters wide. The compression of air which is necessary is equal to a column of water four feet and a half high. The ore melts as it passes through the fire, and is collected at the bottom, where it is maintained in a liquid state. The slag, which falls down with the fused metal, is let off by means of an opening in the side of the furnace, at the discretion of the workmen. When a sufficient quantity of regulus, or imperfectly reduced metal, is accumulated at the bottom of the furnace (which usually happens every eight hours), it is let off into moulds, to form it for the purposes intended, such as cannon or pig iron.—Crude iron is distinguished into white, black, and grey. The white is the least reduced, and more brittle than the other two; the black is that with which a large quantity of fuel has been used; and the grey is that

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which has been reduced with a sufficient quantity of fuel, of which it contains a part in solution. The operation of refining crude iron consists in burning the combustible matter which it holds in solution; at the same time that the remaining iron is more perfectly reduced, and acquires a fibrous texture. For this purpose, the pigs of cast iron are taken to the forge, where they are first put into what is called the refinery; which is an open charcoal fire, urged by a pair of bellows, worked by water or a steam-engine; but the compression of air in the refinery ought to be less than that in the blast-furnace. After the metal is melted, it is let out of the fire by the workmen to discharge the scoriæ, and then returned and subjected to the blast as before. This operation is sometimes repeated two or three times before any appearance of malleability (or what the workmen call coming into nature) takes place; this they know by the metal's first assuming a granular appearance, the particles appearing to repel each other, or at least to have no signs of attraction. Soon afterwards they begin to adhere, the attraction increases very rapidly, and it is with great difficulty that the whole is prevented from running into one mass, which it is desirable to avoid, it being more convenient to stamp small pieces into thin cakes: this is done by putting the iron immediately under the forge-hammer, and beating it into pieces about an inch thick, which easily break from the rest during the operation. These small pieces are then collected and piled to the height of about ten inches upon circular stones, which are an inch thick and nine inches in diameter. They are afterwards put into a furnace, in which the fire is reverberated upon them until they are in a semi-fluid state. The workmen then take one out of the furnace, and draw it into a bar under the hammer; which being finished, they apply the bar to another of the piles of semi-fluid metal, to which it quickly cements, is taken again to the hammer, the bar first drawn serving as a handle, and drawn down as before. The imperfections in the bars are remedied by putting them

into another fire called the chafery, and again subjecting them to the action of the forge-hammer.

The above method is now most in use, and is called flourishing; but the iron made by this process is in no respect superior to that which I am going to describe. It is however not so expensive, and requires less labour.

The process for refining crude iron, which was most common previous to the introduction of flourishing, is as follows:

The pigs of cast iron are put into the refinery, as above, where they remain until they have acquired a consistence resembling paste, which happens in about two hours and a half. The iron is then taken out of the refinery, and laid upon a cast iron plate on the floor, and beaten by the workmen with hand-hammers, to knock off the cinders and other extraneous matters which adhere to the metal. It is afterwards taken to the forge-hammer, and beaten first gently, till it has obtained a little tenacity; then the middle part of the piece is drawn into a bar about half an inch thick, three inches broad, and four feet long, leaving at each end a thick square lump of imperfect iron. In this form it is called ancony. It is now taken to the fire called the chafery, made of common coal; after which the two ends are drawn out into the form of the middle, and the operation is finished.

There is also a third method of rendering crude iron malleable, which, I think, promises to be abundantly more advantageous than either of the two former, as it will dispense both with the refinery and chafery; and nothing more will be necessary than a reverberating furnace, and a furnace to give the metal a malleable heat, about the middle of the operation. The large forge-hammer will also fall into disrepute, but in its place must be substituted metal rollers of different capacities, which, like the forge-hammer, must be worked either by a water-wheel or a steam-engine.

It is by the operation of the forge-hammer or metal
rollers,

rollers, that the iron is deprived of the remaining portion of impurity, and acquires a fibrous texture.

The iron made by the three foregoing processes is equally valuable, for by any of them the metal is rendered pure; but after those different operations are finished, it is the opinion of many of the most judicious workers in iron, that laying it in a damp place for some time improves its quality; and to this alone some attribute the superiority of foreign iron, more time elapsing between making and using the metal. To the latter part of this opinion I can by no means accede, as it is well known that the Swedish* ores contain much less heterogeneous matter than ours, and are generally much richer, as they usually yield about 70 *per quintal* of pure iron, whereas the average of ours is not more than 30 or 40†: add to this, that the Swedish ores are smelted in wood fires, which gives the iron an additional superiority.

Iron instruments are case-hardened by heating them in a cinder or charcoal fire; but if the first be used, a quantity of old leather or bones must be burnt in the fire, to supply the metal with carbon. The fire must be urged by a pair of bellows to a sufficient degree of heat, and the whole operation is usually completed in an hour.

The process for case-hardening iron is in fact the same as for converting iron into steel, but not continued so long, as the surface only of the article is to be impregnated with carbon. Some attempts have been made to give cast-iron, by case-hardening, the texture and ductility of steel; but they have not been very successful. Table and pen-knife blades have been made of it; and, when ground, have had a pretty good appearance; but the edges are not firm, and they soon lose their polish. Common table knives are frequently made of this metal. The cementation of iron converts it into

* Steel is commonly made of Swedish iron.

† The iron made from the ore found in the neighbourhood of Sheffield contains a great deal of phosphate of iron or siderite, which renders the metal brittle when cold.

steel, a substance intermediate between crude and malleable iron.

The furnaces for making steel are conical buildings ; about the middle of which are two troughs of brick or fire-stone, which will hold about four tons of iron in the bar. At the bottom is a long grate for fire. The steel furnace, however, is not well adapted for description. I shall therefore avail myself of an accurate drawing, which was communicated to me by a gentleman conversant with the manufacture, and which is copied in the plate. A layer of charcoal-duft is put upon the bottom of the trough, and upon that a layer of bar iron, and so on alternately until the trough is full. It is then covered over with clay to keep out the air ; which, if admitted, would effectually prevent the cementation. When the fire is put into the grate, the heat passes round by means of flues, made at intervals, by the sides of the trough. The fire is continued until the conversion is complete, which generally happens in about eight or ten days. There is a hole in the side, by which the workmen draw out a bar occasionally, to see how far the transmutation has proceeded. This they determine by the blisters upon the surface of the bars.

If they be not sufficiently changed, the hole is again closed carefully, to exclude the air ; but if, on the contrary, the change be complete, the fire is extinguished, and the steel is left to cool for about eight days more, when the process for making blistered steel is finished. For small wares, the bars are drawn, under the tilt hammer, to about half an inch broad and $\frac{3}{16}$ of an inch thick. The change wrought on blistered steel by the tilt hammer, is nearly similar to that effected on iron from the refinery by the forge hammer. It is made of a more firm texture, and drawn into convenient forms for use. German steel is made by breaking the bars of blistered steel into small pieces, and then putting a number of them into a furnace ; after which they are welded together and drawn to about eighteen inches long ; then doubled and welded again, and finally drawn to the size and shape required

required for use. This is also called shear steel, and is superior in quality to the common tilted steel. Cast steel is also made from the common blistered steel. The bars are broken, and put into large crucibles with a flux. The crucible is then closed up with a lid of the same ware, and placed in a wind furnace. By the introduction of a greater or smaller quantity of flux, the metal is made harder or softer.

When the fusion is complete, the metal is cast into ingots, and then called ingot steel; and that which afterwards undergoes the operation of tilting, is called tilted cast steel. The cast steel is the most valuable, as its texture is the most compact, and it admits of the finest polish. Sir T. Frankland has communicated a process, in the *Transactions of the Royal Society**, for welding cast steel and malleable iron together; which, he says, is done by giving the iron a malleable, and the steel a white heat; but, from the experiments which have been made at my request, it appears, that it is only soft cast steel, little better than common steel, that will weld to iron: pure steel will not; for, at the heat described by Sir T. the best cast steel either melts, or will not bear the hammer. It may here be observed, as was mentioned before, that steel is an intermediate state between crude and malleable iron, except in the circumstance of its reduction being complete; for, according to the experiments of Reaumur and Bergman, steel contains more hydrogen gas than cast iron, but less than malleable iron;—less plumbago than the first, but more than the latter;—an equal portion of manganese with each;—less siliceous earth than either;—more iron than the first, but less than the second. Its fusibility is likewise intermediate between the bar iron and the crude. When steel has been gradually cooled from a state of ignition, it is malleable and soft, like bar iron; but when ignited and plunged into cold water, it has the hardness and brittleness of crude iron. From the foregoing facts we are justified in drawing the same conclusions with Reaumur and

* *Phil. Trans.* 1795.

Bergman, but which have been more perfectly explained by Vandermonde, Berthollet, and Monge, that crude iron is a regulus, the reduction of which is not complete; and which consequently will differ according as it approaches more or less to the metallic state. Forged iron, when previously well refined, is the purest metal; for it is then the most malleable and the most ductile, its power of welding is the greatest, and it acquires the magnetic quality soonest. Steel consists of iron perfectly reduced and combined with charcoal; and the various differences in blistered steel, made of the same metal, consist in the greater or less proportion of charcoal imbibed. Iron gains, by being converted into steel, about $\frac{1}{180}$ part of its weight. In order to harden steel, it must be put into a clean charcoal, coal or cinder fire, blown to a sufficient degree of heat by bellows. The workmen say, that neither iron nor steel will harden properly without a blast. When the fire is sufficiently hot, the instrument intended to be hardened must be put in, and a gradual blast from the bellows continued until the metal has acquired a regular red heat: it is then to be carefully quenched in cold water. If the steel be too hot when immersed in water, the grain will be of a rough and coarse texture; but if of a proper degree of heat, it will be perfectly fine. Saws and some other articles are quenched in oil. Steel is tempered by again subjecting it to the action of the fire. The instrument to be tempered we will suppose to be a razor made of cast steel. First rub it upon a grit stone until it is bright, then put the back upon the fire, and in a short time the edge will become of a light straw colour, whilst the back is blue. The straw colour denotes a proper temper, either for a razor, graver, or pen-knife. Spring knives require a dark brown; scissars a light brown or straw colour; forks or table-knives a blue. The blue colour marks the proper temper for swords, watch-springs, or any thing requiring elasticity. The springs for pen-knives are covered over with oil before they are exposed to the fire to temper.

Explanation of the Plate.

Fig. 1 is a plan of the furnace, and fig. 2 is a section of it taken at the line AB. The plan is taken at the line CD. The same parts of the furnace are marked with the same letters in the plan and in the section. EE are the pots or troughs into which the bars of iron are laid to be converted. F is the fire-place; P the fire-bars; and R the ash-pit. GG, &c. are the flues. HH is an arch, the inside of the bottom of which corresponds with the line IIII, fig. 1, and the top of it is made in the form of a dome, having a hole in the centre at K, fig. 2. LL, &c. are six chimneys. MM is a dome similar to that of a glass-house, covering the whole. At N there is an arched opening, at which the materials are taken in and out of the furnace, and which is closely built up when the furnace is charged. At OO there are holes in each pot, through which the ends of three or four of the bars are made to project quite out of the furnace. These are for the purpose of being drawn out occasionally to see if the iron be sufficiently converted.

The pots are made of fire-tiles or fire-stone. The bottoms of them are made of two courses, each course being about the thickness of the single course which forms the outsides of the pots. The insides of the pots are of one course, about double the thickness of the outside. The partitions of the flues are made of fire-brick, which are of different thicknesses, as represented in the plan, and by dotted lines in the bottom of the pots. These are for supporting the sides and bottoms of the pots, and for directing the flame equally round them. The great object is to communicate to the whole an equal degree of heat in every part. The fuel is put in at each end of the fire-place, and the fire is made the whole length of the pots, and kept up as equally as possible.

XII. *Account of a Violet Dye produced from the Leaves of Succotrine Aloes, which resists the Action of Oxygen, Acids and Alkalis. By Mr. FABBRONI. From the Annales de Chimie, Vol. XXV.*

TO increase the number of dyeing substances, and to be able to vary the tone and shades of the different known colours, is an object of no small utility. Several manufactures, as is well known, have been indebted for their reputation and credit to the possession of a particular dye.

Without speaking of the Tyrian purple, who is ignorant how much value the modern scarlet has given to the Dutch cloths and to those of the Gobelins? Who does not know that the beautiful black of Florence, which has never yet been imitated, has raised the Florentine stuffs all over Europe to a price to which that of no other country ever attained?

Scarlet and black belong to that class of colours called *noble* or *fixed*, because they are not susceptible of being stained, and because they experience no alteration either from the air or from light. The beautiful red colour also given to silk by safflower is reckoned among the noble colours, though it does not withstand the influence of these two agents, which soon destroy it or render it pale.

All other red dyes for silk, in order to be durable, must be composed, in part, of cochineal, which is a colouring substance exceedingly constant.

Argol and all the other lichens produce a very beautiful violet; but the sun alters this colour and makes it turn blue.

I am of opinion, therefore, that if means could be discovered to compose, without cochineal, colours graduated from the most delicate to the darkest violet purple, which might be proof against the action of acids and of the air, infinite advantages would thence result to the manufacturers of cloth and to the public.

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It was in hopes of discovering such a colour that I directed my researches towards a substance which hitherto has not been ranked among those called colouring substances.

I was persuaded that the matter of the brilliant colours presented to us in those fruits, flowers, and plants, which have undergone a spontaneous alteration, pre-exists in the mass of the fluids that circulate in those organs, where it is dispersed or concealed; and that to be able to turn it to advantage, nothing would be wanting but a method to separate it, and to modify it in a proper manner.

The cochineal insect, which lives on the nopal (*cactus coccinifer*), can extract with its proboscis the red juice, or juice susceptible of becoming red, of that plant; which afterwards communicates its colour to the insect, and which, in my opinion, is the same as that exhibited to us naked in the ripe fruit of the same plant.

The beautiful scarlet colour assumed by the dead leaves of some species of strawberry blite (*blitum*) is not perhaps brought forwards but in consequence of the decomposition of the dead leaf. Would it be impossible then for art to separate this colour, and to modify it in the like manner?

Having observed that the succulent leaves of the *aloe succotrina angustifolia*, as they dried on the plants, assumed an agreeable violet colour, I tried to separate the colouring matter, or principles of that fine colour, from the living leaves.

I found by experiments, that acids as well as alkalis speedily gave to this almost colourless juice a red colour, and formed a successive precipitation of colouring molecules which had the same colour.

Oxygen gas produced the like effect; and it is highly pleasing to see how the juice of aloes, merely by being exposed to the air, with or without the contact of the light, successively reddens, beginning at the parts more immediately in contact, and is gradually converted into a very dark and lively violet purple.

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This juice then produces a superb transparent colour without body, highly proper for works in miniature, and which when dissolved in water may serve also, either cold or warm, for dyeing silk from the lightest to the darkest shade.

Silk, even without a mordant, strikes and becomes impregnated with this dye. It is equally attracted by sulphurated silk, though the latter is so little disposed to assume any colour whatever.

The aloe, indeed, is not a plant indigenous in our climates; but this is an inconvenience which it has in common with almost all substances used for dyeing, and even with a great number of those which serve us as food. The juice might be procured from Socotora itself, not such as it is found in commerce inspissated by fire, but dried in the air, or prepared by an acid.

Besides, as this plant grows without any difficulty in our botanical gardens, we may hope to multiply it enough by cultivation, particularly in the southern parts of Italy, in order to extract from it the juice ourselves.

The value of this new colour may be readily discovered, when we observe that, by its property of not being altered by acids or alkalis, it possesses the uncommon quality of not being susceptible of becoming spotted.

When we consider also that the oxygen, which discolours our cloths and silks so as to render them white, is, as one may say, the principle which develops the colour of the aloe; it ought to be inferred, that the air cannot alter a quality which it communicates itself; and we may therefore conclude, that we have discovered in the aloe one of the most durable colours known in nature.

XIII. *A cursory View of some late Discoveries and Improvements in different Branches of Science. Extracted chiefly from DE LA METHERIE'S Introduction to the Journal de Physique for 1798.*

MATHEMATICS.

THIS sublime part of knowledge, though carried in all appearance to its utmost extent, still continues to make some progress. Lagrange has finished a very important work, which he began several years ago, entitled, *The Theory of the Analytical Functions*, &c. in which he shews that every thing hitherto called the differential calculus, whether one follows the method of Leibnitz or that of Newton, may be reduced to the ordinary calculation of finite quantities.

ASTRONOMY. Herschel, who has paid great attention to the spots of the sun, considers that luminary as similar to the planets, and not a flaming body. It contains mountains, some of which he supposes to be 200 leagues in height. Its atmosphere is composed of different elastic fluids, some of which are luminous or phosphoric, and others only transparent. The former make the sun appear like a mass of light or fire; but the parts of that atmosphere which are only transparent, suffer his body to be seen. These are the spots. He believes the sun to be inhabited like the other planets.

Lalande, on the other hand, thinks that the sun is really a solid body, but that his surface and part of his mass are composed of an incandescent fluid. This fluid, by any movement, leaves uncovered sometimes a portion of the body of the sun or his mountains, and these are the spots. Wilson considers the spots of the sun as eruptions or volcanoes.

Shroeter has shown that in Venus there are very high mountains, as is the case on the earth and in the moon. The greater part of these mountains in Venus, like those of
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the moon, are in the southern part of that planet, while on the earth the greater part of the mountains are towards the north. The day in Venus appears to that astronomer to be 23 hours 21 minutes. It differs therefore very little from the sidereal day of the earth, which is 23 hours 56 minutes 4 seconds.

The volcano of the moon has been seen several times by the naked eye. Caroché saw it at Paris on the second of March 1797. It exhibited the appearance of a candle just going out. It resembled a brilliant spot less sensible than the greatest satellite of Jupiter, but larger. Its existence therefore can no longer be doubted.

La Place has published an excellent memoir on the movements of the moon.

Hennert says that the diurnal movement of the earth may undergo some variations; but that its variations are compensated in such a manner, that they may be considered as uniform.

Herschel has observed around Saturn a quintuple belt of spots. By these means he has shown the length of the day of that planet, and determined its diurnal rotation, which he estimates at 10 hours 16 minutes 2 seconds.

Lalande calculated the orbit of the 83d comet to the month of December 1793; but an 84th comet was seen by Bode at Berlin, on the 11th of November 1795, near the constellation of Hercules. It was seen also by Bouvard, at Paris, on the 14th of the same month. It was small, had no tail, and was not visible to the naked eye. Its orbit has been calculated by Zach. It was in its perihelion on the 14th of December at 15 hours 32 seconds mean time at Gotha. Its distance then from the sun was 0,22.

An 85th comet was discovered in Virgo by Olbers, at Bremen, who calculated its orbit.

An 86th was discovered from the observatory at Paris, by Bouvard, on the 14th of August 1797, at ten o'clock at night. It was seen next day, at Leipzig, by Rudiger. It was
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seen also by various astronomers in other places. It passed the earth six times nearer than the sun, which was the cause of its apparent motion being very rapid. It was small, appeared only like a faint white spot, and had no tail. Zach, at Gotha, makes the number of the comets now known to be 90.

One of the most difficult labours of astronomy is what relates to the stars. Their immense number indeed is sufficient to deter any one from the task of numbering them; for those which we see, and we are far from seeing them all, may be estimated at more than a hundred millions. Many of these it is well known have peculiar motions, some of which are very considerable. It is to them, however, that we are obliged to refer all the motions of the sun, the planets, and the comets. It is of importance then to endeavour to determine the motions of the stars; and this object has at all times engaged the attention of astronomers. Maskelyne has determined with the utmost precision the position of 34 stars. Zach has accomplished the same thing in regard to 1200. Lalande, with his nephew and niece, have undertaken a labour far greater, to determine the position of more than 40,000 stars, from the arctic pole to the tropic of capricorn. This sublime task is already very much advanced, as the positions of 42,700 are already known.

HYDROSTATICS.—Venturi has made interesting experiments on the lateral efflux of fluids. He shews that the efflux is more considerable, when a pipe, rather a little long, is adjusted to the aperture of the vessel, than when there is no pipe, or only one that is short. Thus, when one wishes to draw wine, the jet will be more considerable by putting a cock into the aperture of the cask, than if there were no cock; and if the cock be some inches in length, the quantity that flows out will be greater than if it were very short.

It is well known, that when small bits of camphor and other substances, such as the juice of the euphorbium, are placed upon water, they appear agitated in a very remarkable

able manner. Romieu ascribed this phenomenon to electricity, but Volta has proved that electricity has no connection with it. Lichtenberg was of opinion, that camphor, losing a great deal by evaporation, continually decreases in bulk, and that these small fragments of it change their configuration, which makes a variation in their respective attractions. Volta thinks that the vapours which exhale from these bodies strike the air and the water with sufficient force to cause the molecule, from which these vapours are exhaled, to be agitated as above mentioned.

Brugnattelli has convinced himself that this phenomenon takes place with all substances that contain much essential oil, such as the leaves of laurel, sage, thyme, vanilla, the nutmeg-tree, the *rhus toxicodendron* (the poison oak), the *rhus vernix* (the poison-ash). He found also that small bodies which did not move on the water acquired that property after being impregnated with essential oil. A piece of bread, for example, rubbed against a piece of lemon-peel and impregnated with essential oil of lemons, moved, after being placed upon water a little warm.

These experiments prove that it is jets of essential oil thrown out with rapidity from these bodies, which make them move on the water. These jets experience a resistance from the air and the water, as a lighted rocket experiences a resistance from the air by which it is made to ascend; that is to say, in a direction opposite to the jet of the flame.

Venturi, who repeated all these experiments, made several small sticks of camphor, which he placed on water, adding to them a bit of lead by way of ballast. They all moved as usual; but he observed them become a little smaller above the surface of the water, and at length break in two. This effect is more speedy if the water be a little warm, and is occasioned by the continual evaporation of the parts.

BOTANY.—Though the number of plants is so considerable, being estimated at about twenty thousand, that the most retentive memory can scarcely remember their names, the ardour for this branch of science does not seem to decrease.

La Billardiere, who went round the world with d'Entrecasteaux, brought back with him a valuable collection in every part of natural history. His herbal is most beautiful; and though nearly one fourth of it has been lost, he has still about three thousand plants, of which from twelve to fifteen hundred are new.

He carried with him from the Friendly Isles twenty-two bread-fruit-trees, twelve of which were left at the Isle de France. Of the eight brought to France, five died; two have been sent to Cayenne; and the other was brought to Paris, where it is now in the *Jardin des Plantes*.

La Billardiere brought with him also about three hundred birds, a third of which almost are unknown. His collection of insects has been much damaged; but he has still a great many in sufficient preservation to be described. Riché, who went on the same expedition, brought with him a variety of objects, and particularly birds. He died not long ago.

Michau has returned from South America, and brought with him a great number of plants in excellent preservation. He will no doubt soon publish an account of them, as well as of those which he brought from Persia.

Coulomb having ordered some poplars to be cut down in the spring time, observed, that when the axe approached the centre of the tree, a very large quantity of air was disengaged, but that none was disengaged when the instrument attacked the other parts of the tree. It is well known that the *medullary part*, in which the air circulates particularly, is situated towards the centre. From this medullary part proceed those transversal vessels which extend to the bark of the tree for the circulation of the air. The plant contains also other vessels for the circulation of the sap and of all the vegetable juices. There are also glands where the secretion of all these different liquors is performed to produce the *propolis*, *pollen*, &c. A vegetable, therefore, in the simplest case, may be considered as an assemblage of several pliable elastic fibres,

composing

composing a great number of vessels of different calibres, in which water, air, and various kinds of fluids drawn from the bosom of the earth and the atmosphere, circulate.

Light also has a great influence on vegetation. Humboldt has shown that the light of a lamp may, in this respect, supply that of the sun; and that plants which receive the light of a lamp are coloured green, as if they received that of the sun. Excess of light hurts plants, especially when they begin to rise.

According to Ingenhouz, plants suffer oxygen to be disengaged in the light, and the carbonic acid in darkness. Senebier is of opinion that the latter changes the oxygen into the carbonic acid, by furnishing it with carbon.

Humboldt has observed that mushrooms furnish hydrogenous gaz in the day, as well as the night-time.

MEDICINE.—The carbonate of barytes and pure caustic barytic earth are most active poisons. Pelletier killed several dogs by making them take from twelve to eighteen grains of these substances.

Mankind have been long employed in attempting to discover means for the prolongation of life. Valli, after laying down principles well known, viz. that old age comes on naturally, because the calcareous phosphate or calcareous carbonate is continually accumulating in the greater part of the solids, such as the bones, the arteries, veins, tendons, &c. says, that this accumulation can be guarded against only two ways; either by preventing that substance from being formed in the mass of the fluids, or by expelling it as soon as it is formed.

1. To prevent too abundant a production of that earth, one must use aliments which contain the least quantity of it, such as vegetables, milk, fish (but fishes contain a great deal of the phosphoric acid).

2. The means which he thinks most proper for expelling that calcareous earth, or calcareous phosphate, are, bathing, frictions, diuretics, pure water, and beverages cooled
with

with ice. In short, he considers the oxalic acid given in small doses as the best remedy. That acid, says he, decomposes the calcareous phosphate : the oxalate of lime which thence results will be carried into the torrent of circulation, and will be driven outwards.

Vauquelin and Brogniard have proved that the acetic acid dissolves the vegetable gluten and the animal fibres.

It is well known that there is a disease called by nosologists *malacoſteon*, or *mollities ossium*, where the bones become entirely soft. The calcareous phosphate is almost entirely carried away, and there scarcely remains any thing but the cellular tissue of the bones, with the gelatinous and greasy part, or the marrow. Were it possible to find out the means of dissolving, gradually, in this manner the calcareous phosphate, without depriving the bones of their solidity, and without hurting the other animal functions, the fountain of youth would be discovered. It appears therefore that it may not be altogether impossible to retard age at least.

PHYSIOLOGY.—Spallanzani having destroyed the eyes of bats and set them at liberty in an apartment, observed that they could guide themselves from one place to another as before. They avoided every obstacle that was presented to them, and even passed through rings which he placed before them : and for this reason he asks, “ May not these animals possess a sense with which we are not acquainted, and which may supply that of sight ? or, May not smell be sufficient for that purpose ? ”

Jurine is of opinion that it is hearing which supplies the above want. He filled with wax one of the ears of those animals which he had deprived of sight, and he observed that they flew about with difficulty : when he filled both their ears, they could not fly at all.

[To be continued.]

XIV. *An Account of two singular Meteors.*

A LUMINOUS body was observed in the canton of Calvire, on the evening of the 8th of March last. It appeared to direct its course from the east to the west, traversing the heavens from Calvire to Mont-d'Or, where it fell. It made itself be distinguished in its course by a noise like that of a long and violent discharge of musketry. Lalande has published the following note respecting these singular meteors :

“ One frequently observes,” says he, “ globes of fire in the atmosphere. I have mentioned above 36 instances of that kind in the *Connoissances des Temps* for the year 1779. That observed on the 18th of Ventose (March 8) in the department of Ain, at seven in the evening, was attended with some singular circumstances. The heavens were serene, and a large globe, as big as the moon, was seen to proceed from the east, and to advance with a rapid motion towards the west. It was followed by a train of light, the rays of which, collected into bundles, were terminated by small globes. Six or seven sprigs of stars were seen on each side of the train. At the end of some seconds there was an explosion like a lengthened clap of thunder, or the loud report of a cannon. This meteor diffused such a light that day seemed to have returned, and people in dark apartments could see each other.

“ This globe was at such a distance, that it could be seen, at the same time, in places seven or eight leagues asunder. A description of it was sent to me by citizen Riboud, at Jofferan, and citizen Langeron, at Thorsey. Had it been at a greater distance, it would have appeared only like those falling stars which are observed so frequently. The common cause of these phenomena appears to be hydrogenous gas, set on fire, by some means, in the atmosphere.”

On the 25th of March the following curious phenomenon was observed at Niort : Between the hours of six and eight in the morning the sun appeared accompanied by two radiant

art circles resembling two other suns, one on the right and the other on the left, and which with the real sun as a base seemed to compose a triangle. These two supernumerary suns were so exceedingly bright, that it was impossible to keep the eyes fixed on them for any length of time. They disappeared gradually; that on the east disappeared first, and at the end of two hours they were both invisible.

The wind for ten days had been E.N.E., and a cold much greater than usual for the season had some days before succeeded mild weather accompanied with a little rain. On the 18th of March the mercury in the barometer had fallen to 26,8. On the 20th of the same month there were several heavy showers of large hail at different times. On the 24th the electrical machine emitted very strong sparks almost without being solicited; and at the time when the phenomenon appeared, a few clouds scarcely perceptible were to be seen in the high regions of the atmosphere.

Phenomena of the above kind, though not frequent, have been seen at different periods. Augustine takes notice of two mock suns which were seen before the christian æra, Zonaras mentions two seen after the death of Christ, Palmerius three seen in 1466, Surius three suns, i. e. two parhelia seen at Wirtenberg in 1514, Fromundus three suns seen in 1619, Cardan three at Venice in 1532.

In Britain, if we may credit our old chronicles, five suns were plainly seen at one time, and a great distance from one another, in the year 346: three were seen in 812; three in 953; and five in 1233. Lilly mentions three seen on the 19th of November, 1644; and three seen on the 28th of February, 1648. A most remarkable phenomenon of this kind, where five parhelia were seen at once, is mentioned in the 8th volume of the *New Transactions of the Imperial Academy at Petersburg*; an account of which, with an engraving, will be given in a subsequent number.

XV. *On a new Acid procured from Animal Substances, called the Zoonic Acid.* By Mr. BERTHOLLET. From the *Annales de Chimie*, Vol. XXVI.

THE liquid procured by distillation from animal substances has appeared hitherto to contain only carbonate of ammoniac and an oil; but I have found in it an acid, to which I have given the name of the *zoonic acid*. I observed this acid in the liquid obtained from the gluten of wheat, the yeast of beer, bones, and woollen rags, distilled for the preparation of the muriate of ammoniac. I think myself therefore authorised to consider it as produced by the distillation of all animal substances.

To separate this acid, I mix quicklime with the distilled liquid after having separated the oil, and then boil or distil the mixture. The carbonate of ammoniac is exhaled; and when the odour ceases to be sharp (*piquant*), I filter, and add a little quicklime to the liquid, which I boil again, till the smell of the ammoniac goes off entirely. What remains is zoonate of lime, which I filter again. I then pour upon it water impregnated with carbonic acid, or I blow into the liquid with my mouth, through a tube, in order to precipitate, by the carbonic acid of the respired air, the quicklime which may be held in solution without being combined. Zoonate of lime may therefore be employed to effect combinations by complex affinities; but to obtain the zoonic acid pure I make use of the following process: I mix the solution of zoonate of lime in water, made pretty strong (*raprochée*) in a tubulated retort with the phosphoric acid; I then distil it. The distillation, as the zoonic acid has very little volatility, requires a degree of heat nearly equal to that of boiling water. The liquor must then be made to boil. If two vessels be adapted, one after the other, nothing will pass into the second. It appears that a part of the acid is destroyed by the action of the heat; for the liquid which

is in ebullition becomes brown, and grows black at the end of the operation. It may thence be concluded that this acid contains carbon. I have not been able to collect the other principles which are disengaged during the decomposition.

The zoonic acid has an odour like that of meat when frying, and is indeed formed during that process. It has an austere taste. I have been able, as yet, to make on this acid only a small number of experiments, which exhibited no remarkable property. It gives a strong red colour to paper tinged with turnsol, and produces an effervescence with alkaline carbonates. It did not appear to me to produce with alkaline and earthy bases salts which crystallize. It forms a white precipitate in a solution of acetite of mercury in water, and in that of the nitrate of lead; so that it has more affinity with the oxyde of mercury than the acetous acid, and with the oxyde of lead than the nitric acid. It acts on the nitrate of silver only by complex affinity; and the precipitate it then forms grows brown with time, which shews that this precipitate contains hydrogen. The zoonate of potash calcined did not form prussiate of iron with a solution of that metal. A liquid, which had all the indications of acidity, separated from flesh which I kept a long time in a state of putrefaction, but it was an ammoniacal salt with excess of acid: this acid combined with lime appeared to me like zoonate of lime; but I had too little of it to establish exactly its identity with the zoonic acid.

XVI. *Biographical Memoirs of the late PETER NIEUWLAND.*

From his Eloge read at Amsterdam, Nov. 24, 1794, in the Society Felix Meritis.

PETER NIEUWLAND, professor of mathematics and natural philosophy in the university of Leyden, was born at Diemer-

meer, a village near Amsterdam, on the 5th of November, 1764. His father, by trade a carpenter, having a great fondness for books, and being tolerably well versed in the mathematics, instructed his son himself till he attained to his eleventh year. Young Nieuwland appears to have displayed strong marks of genius at a very early period. When about the age of three, his mother put into his hands some prints by John Luiken, which had fifty verses at the bottom of them by way of explanation. These verses she read to him aloud, without any intention that her son should learn them; and she was much surprised some time after to hear him repeat the whole from memory with the utmost correctness, on being only shewn the prints. Before he was seven years of age he had read more than fifty different books, and in such a manner that he could frequently repeat passages from them both in prose and in verse. When about the age of eight, Mr. Aeneas at Amsterdam, one of the greatest calculators of the age, asked him if he could tell the solid content of a wooden statue of Mercury which stood upon a piece of clock-work. "Yes," replied young Nieuwland, "provided you give me a bit of the same wood of which the statue was made; for I will cut a cubic inch out of it, and then compare it with the statue." Poems which display the utmost liveliness of imagination, and which he composed in his tenth year, while walking or amusing himself near his father's house, were, though written at so tender an age, received with admiration and inserted in different poetical collections.

Such an uncommon genius must soon burst through those obstacles which confine it. Bernardus and Jeronimo de Bosch, two of the first and wealthiest men at Amsterdam, became young Nieuwland's benefactors, and contributed very much to call forth his latent talents, and to enable the powers of his mind to expand. He was taken into the house of the former in his eleventh year, and he received daily instruction from the latter for the space of four years. While in this situation he made considerable progress

gress in the Latin and Greek languages, and he studied philosophy and the mathematics under Wytttenbach. In the year 1783 he translated the two dissertations of his celebrated instructors, Wytttenbach and de Bosch, on the opinions which the ancients entertained of the state of the soul after death, which had gained the prize of the Teylerian theological society.

From the month of September 1784 to 1785, Nieuwland resided at Leyden as a student in the university, and afterwards applied with great diligence, at Amsterdam, to natural philosophy and every branch of the mathematics, under the direction of Professor van Swinden. In these pursuits, indeed, he had scarcely any occasion for a master; for he possessed the peculiar talent of uniting different sciences, and of comprehending their principles with the utmost facility. He had scarcely begun to turn his attention to chemistry, when he made himself master of the theory of the much-lamented Lavoisier, and could apply it to every phenomenon. He could read a work through with uncommon quickness, and yet retain in his mind the principal part of its contents.

Nieuwland's attention was directed to three principal pursuits: poetry, the pure mathematics, and natural philosophy. In the latter part of his life he added to these also astronomy. Among the poems which he published, his *Orion* alone has rendered his name immortal in Holland. Of the small essays which he published in his youth, the two following are particularly deserving of notice: 1. *A comparative view of the value of the different branches of science*; and 2. *The best means to render general, not learning, but soundness of judgment and good taste.*

One of his great objects was to bring the pure mathematics nearer to perfection, to amend many faults in them, to clear up and connect their different parts, and in particular to apply them to natural philosophy and astronomy. Cornelius Douwes discovered an easy method of determining the latitude of a place at sea, not by the meridian altitude of the

fun, but by two observations made at any other period of the day. This method, however, being still imperfect, Nieuwland turned his thoughts towards the improvement of it, and in the beginning of the year 1789 wrote a paper on the subject, which he transmitted to M. de Lalande at Paris, from whom it met with great approbation. In the year 1792, when Nieuwland resided two months at Gotha with Major von Zach, these two learned men often conversed on this method of finding the latitude, and calculated the result of observations which they had made with a sextant and an artificial horizon. The above paper, enlarged by these observations, was inserted by Major von Zach with Nieuwland's name in the first Supplement to Bode's *Astronomical Almanack*, Berlin, 1793.

The above, however, was not the only service rendered by this learned man to astronomy. Newton was the first philosopher who spoke of the mutual attraction of the heavenly bodies, and who explained the laws of this attraction from mathematical principles. D'Alembert, Euler, and Clairaut brought still nearer to perfection what Newton had not sufficiently illustrated, and described the motion of the moon, the mutual effect which the planets have on each other, the perturbations that must thence be produced in their courses and the periods of their revolutions, and also the laws to which these perturbations are subject. There however still remained to be explained some irregularities in the phenomena of the planets, and that slow variation which takes place in the inclination of the ecliptic. De la Place also made some very accurate calculations on this subject. All these great men adopted a truth, which they knew only from observations, that the axes of the planets do not stand perpendicular, but inclined to the plane of their orbits. The axis of the earth, for example, makes with the plane of its orbit, that is, with the ecliptic, an angle of almost sixty-six degrees and a half, and this inclination alone produces the seasons; whereas, if the axis of the earth stood perpendicular,

we should continually have the same season, and the days and the nights always equal. The cause, however, of this inclination was still unknown to all the great astronomers. Du Séjour says, in his analytical treatise on the apparent motion of the heavenly bodies, that it is highly probable that this phenomenon depends on some physical cause; but he does not venture to mention it. Nieuwland proceeded farther. He laid down principles from which he drew this conclusion, that the above phenomenon is intimately connected with the whole system of attraction. On these principles he made calculations, the result of which was exactly equal to the angle of the inclination of the earth's axis to the plane of its orbit. Nieuwland communicated his discovery with much modesty to the celebrated Professor Damen at Leyden, who proposed some objections to it which discouraged Nieuwland, and induced him to revise his calculations with more accuracy. Major von Zach transmitted the paper which contained them to M. De la Place at Paris, and caused it to be printed also, for the opinion of the learned, in the Supplement to Professor Bode's Astronomical Almanack for the year 1793.

Nieuwland's talents and diligence soon recommended him to the notice of his country. When in his twenty-second year, he was appointed a member of the commission chosen by the College of Admiralty at Amsterdam for determining the longitude and improving marine charts. On this labour he was employed eight years, and undertook also to prepare a nautical almanack, and to calculate the necessary tables. The mathematical part was in general entrusted to Nieuwland; but he assisted also his two colleagues van Swinden and van Keulen, in the departments assigned to them, with such assiduity, that most of the work published on the longitude, together with the three additional parts, were the fruits of his labour. In the second edition of the explanation of the nautical almanack, he had also the principal share, and he was the author, in particular, of the explanation of the equation

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tion of time, the method of determining the going of a time-piece, and of calculating the declination of the moon.

Soon after Nieuwland engaged in this employment it appeared as if his destination was about to be changed. In the year 1787 he was chosen by the States of Utrecht to succeed Professor Hennert; but on account of certain circumstances this appointment did not take place. He was however invited to Amsterdam by the magistrates of that city, to give lectures on the mathematics, astronomy, and navigation. While in this situation he wrote his useful and excellent treatise on navigation, the first part of which was published at Amsterdam in 1793, by George Hulst van Keulen; and it is much to be wished that M. van Swinden would complete this work from the papers bequeathed to him by his deceased friend the author.

In astronomical pursuits, Nieuwland applied not only to the theoretical but also to the practical part; and in this study he was encouraged and assisted by Major von Zach, with whom he resided some time in the course of the year 1792, after the death of his wife, and who instructed him in the proper use of the sextant. This affectionate friend published also all his observations and calculations in the before-mentioned Supplement to Bode's Astronomical Almanack.

In the year 1789 Nieuwland was chosen member of a learned society whose object was chemical experiments; and so apt was his genius for acquiring knowledge, that in a little time he made himself completely master of the theory of chemistry. A proof of this is the treatise which he read on the 24th of May 1791, in the society distinguished by the motto of *Felix Meritis*, and which has been printed in the first part of the New General Magazine (*Nieuw Algemeene Magazyn*). At the same time he was able to examine the important discoveries made by the society, to assist in preparing an account of them for the press, and to publish them with sufficient accuracy in the French language. Three parts of this work appeared under the title of *Recherches*

Physico-chymiques. The first part appeared in 1792, and was afterwards re-printed in the *Journal de Physique*. The second was published in 1793, and the fourth in 1794. Some letters of his on chemistry may be found also in the *Messenger* (*Letterbode*).

This ingenious and diligent man was of great service also in the philosophical department to the above society, *Felix Meritis*, of which he was chosen a titular member on the 25th of January 1788, and an honorary member on the 15th of March 1791. The papers for which it was indebted to him are as follows :—1. *On the newest discoveries in astronomy, and the progress lately made in that science*, 1788. This is an extract from a Latin oration which he intended to have delivered at Utrecht when he expected to succeed Professor Hennert.—2. *On the figure of the earth*, 1789.—3. *On the course of comets, and the uncertainty of the return of the comet now expected*, 1790.—4. *On the nature of the mathematics*. The principal object of this paper was to illustrate the idea, that the mathematics may be considered as a beautiful and perfect language.—5. *On the periodical decrease or increase in the light of certain fixed stars, and particularly of the star Algol*, 1790.—6. *On the solution of spherical trigonometry by means of a new instrument invented by Le Guin*, 1791. M. le Guin having transmitted to the College of Admiralty at Amsterdam an instrument which might be used with great advantage in trigonometrical operations, and by which, in calculating the longitude, one could deduce the real from the apparent distance, the Admiralty charged Nieuwland to examine this instrument; and he found that it might be of excellent service for the above purpose.—7. *On the relative value or importance of the sciences*, 1791.—8. *On the system of Lavoisier*, 1792.—9. *On the Selenotopographia of Schröder*, 1793.—10. *On what is commonly called cultivation, instruction, or enlightening*, 1793.

Nieuwland had applied closely to the mathematics, astronomy and navigation for six years; during which time he made

made considerable improvements in nautical charts, and filled up his vacant hours with the study of philosophy and chemistry. In the month of July 1793 he was invited to the university of Leyden, to be Professor of Philosophy, Astronomy, and the Higher Mathematics, in the room of the celebrated Damen; and the Admiralty of Amsterdam requested him to continue his nautical researches, which he did with great assiduity till the period of his death. The only variation which he now made in his studies related to natural philosophy, for with the mathematics he was already sufficiently acquainted. He applied therefore to the experimental part, and spared no pains nor labour to become perfect in it; which would certainly have been the case, had he not been snatched from science and his friends at the early age of thirty. He died of an inflammation in his throat, accompanied with a fever, on the 13th. of November 1794.

In his external appearance, Nieuwland was not what might be called handsome, nor had he ever paid much attention to acquire that ease of deportment which distinguishes those who have frequented polite company. His behaviour and conversation were however agreeable, because he could discourse with facility on so many subjects, and never wished to appear but under his real character. On the first view one might have discerned that he was a man of great modesty and the strictest morality. His father was a Lutheran, and his mother a baptist; but he himself was a member of the reformed church, and always shewed the utmost respect for the Supreme Being both by his words and his actions.

XVII. *Description of M. DES VIGNES's improved Apparatus for saturating Water, Solutions of Mineral and Vegetable Alkali, &c. &c. with Carbonic Gas; or for making artificial Mineral Waters. Communicated by the Inventor.*

[*With a Plate, No. IV.*]

A, FIG. 1. a bottle or vessel in which marble, chalk, or any other proper substance, is to be put with a little water. B a bottle containing sulphuric acid, and having its neck ground to fit in the first bottle at C, and a cock *a* by which any quantity of the acid can be introduced to the chalk or other substance. As the gas is extricated, it passes through the tube D into the vessel E, which contains the liquid to be saturated: the gas by its elasticity presses the liquor, and forces it through the tube F into G. At H is a small hollow glass ball I with a stem ground to fit the mouth of the vessel G, which it shuts as a valve by the pressure of the liquor, assisted with a spiral spring, until the water or other liquid, which has been forced through the tube F into G, presses down by its weight the ball I, and returns back into E. When it accumulates to a certain point in E, the valve is again shut, and it rises through the tube F as before.

At *b* is a stopper to which hangs a small weight, about half an ounce, which acts as a safety valve to prevent the pressure from reaching that point which would endanger the bursting of the vessels.

The advantage which this apparatus possesses, is, that it not only gives the same pressure of the gas upon the surface of the liquor to be impregnated, which the common machines do, but, by the constant agitation which is kept up, by the ascent and descent of the fluid, continually exposes a fresh surface of it to its action: by which means water or other liquors may be as fully saturated in two hours as they can in twelve, by any apparatus in common use.

Fig. 2 is a section of the valve ball I, the spiral spring K,
and

and the cork L, to which the two former are fastened. At *c* is a piece of lead, which serves at the same time to adjust the weight of the ball, and to keep it in an upright position.

Fig. 3 is a plan of the cork, shewing the apertures through which the liquor descends. The tubes D and F are each in two parts, joined by pieces of elastic gum, by which means the apparatus admits of being moved without danger of breaking. There is also a glass rod *e* in the vessel A for the purpose of stirring the materials. This rod passes tight through a piece of gum elastic (the mouth end of one of the common bottles made of that substance), the other end of which is fitted close to the mouth of the vessel A, by means of wire or catgut wound round it, to prevent the escape of the gas.

XVIII. *Extract from a Memoir by Prof. Jor Klaproth, on a new Metal called Tellurium, read in a public Sitting of the Academy of Sciences at Berlin, Jan. 25th, 1798.*

PROFESSOR Klaproth, on subjecting to a chemical analysis the ore of the auriferous mine known under the denomination of the mine of white gold, *aurum paradoxum, metallum vel aurum problematicum**, found in that mineral a metal absolutely different from any hitherto known, and to which he gave the name of *tellurium*, as a companion to the *uranium* and *titanium*, new metals discovered some time ago by the same chemist. M. Muller of Reichenstein had, so early as 1782, suspected that this ore contained a peculiar metallic substance, and his suspicion was confirmed by Bergman, to whom he had sent some of the ore; but on account of the small quantity with which he had made his experiments he would not venture to decide, whether it contained a new

* This ore is found in the mine called *Mariaberg* in the Fatzbay mountains near Zalethna in Transylvania. See Emmerling *Elements de Mineralogie*, t. xi. p. 124.

metal, or whether what had been taken for a particular kind of metal might not be only antimony. The repeated and ingenious experiments made by M. Klaproth on a more considerable quantity of the ore, which had been transmitted to him by M. de Reichenstein, fully confirmed the conjectures of the latter as well as those of Bergman.

Process for obtaining the Metal from the Ore.

1. The ore is gently heated with six parts of the muriatic acid; three parts of the nitric acid being then added, the mixture is boiled; upon which there arises a very considerable effervescence, and a complete solution is obtained.

2. The filtered solution is diluted with as much water as it can bear without becoming turbid, which is a very small quantity, and a solution of caustic potash is then added to the liquor, until the white precipitate which is at first formed disappears again, and nothing remains but a brown slaky sediment.

3. This last precipitate is the oxyde of gold mixed with the oxyde of iron, and a separation is effected by the common means.

4. The muriatic acid is added to the alkaline solution (2) in sufficient quantity to saturate the alkali entirely: an excess of the acid must be avoided. A white precipitate, which, by heat, settles at the bottom of the vessel under the form of a heavy powder, is produced in great abundance. After the precipitate has been washed and dried, it is formed into a kind of paste with a sufficient quantity of any fat oil; and this mass is put into a small glass retort, to which a recipient is slightly fitted. When this arrangement is made, it is gradually brought to a red heat; and in proportion as the oil is decomposed, there are observed, as in the distillation of mercury, brilliant and metallic drops which cover the upper part of the retort, and which, at intervals, fall to the bottom of the vessel, and are immediately replaced by others. After it has cooled, metallic fixed drops are found adhering to the sides of the retort and at the bottom of the vessel, and the remainder

remainder of the metal reduced and melted with a brilliant surface, and almost always crystallized.

Essential characterising Marks of this new Metal.

1. It has the white colour of tin, approaching to the grey colour of lead. Its metallic splendour is considerable, and its fracture laminated. It is highly brittle and friable. By suffering it to cool quietly and gradually, it readily assumes a crystallised surface.

2. Its specific gravity is 6.115.

3. It belongs to the class of the most fusible metals.

4. When heated by the blow-pipe upon charcoal, it burns with a very lively flame of a blue colour, inclining at the edges to green. It is so volatile as to rise entirely in a whitish grey smoke, and exhales a disagreeable odour like that of radishes. On ceasing to heat it, without having entirely volatilised the small portion subjected to this operation, the button which remained, retained for a long time its liquidity, and, by cooling, was covered with a radiated vegetation.

5. This metal amalgamates easily with mercury.

6. With sulphur it forms a grey sulphure of a radiated structure.

7. A solution of it in the nitric acid is transparent and colourless. When concentrated, it produces, in time, small white light crystals, in the form of needles, which exhibit a dendritic aggregation.

8. The new metal dissolves in the nitro-muriatic acid. When a large quantity of water is added to such a saturated solution, the metal is precipitated in the state of an oxyde, under the form of a white powder, which, in this state, is soluble in the muriatic acid.

9. By mixing cold, in a well-stopped vessel, a small quantity of this metal with a hundred times its weight of concentrated sulphuric acid, the latter gradually assumes a beautiful crimson red colour. By means of a small quantity of water added, drop by drop, the colour disappears, and the

small

small quantity of the metal dissolved, deposits itself under the form of black flakes. Heat destroys the solution: it makes the red colour disappear, and disposes the metal to separate in the state of a white oxyde.

10. When, on the other hand, the concentrated sulphuric acid is diluted with two or three parts of water, and a small quantity of the nitric acid has been added, a considerable quantity of the metal will then be dissolved. The solution is transparent and colourless, and is not decomposed by the mixture of a larger quantity of water.

11. All the pure alkalis precipitate from acid solutions of this metal an oxyde, of a white colour, soluble in all acids: by an excess of alkali, the precipitate which is formed is entirely re-dissolved. If carbonate be employed instead of pure alkali, the same phenomenon takes place—with this difference, however, that, by excess of the latter, the precipitate formed is re-dissolved only in part.

12. Exceedingly pure prussiate of potash produces no precipitate in solutions of this metal.

13. Alkaline sulphures mixed with acid solutions occasion a brown or blackish precipitate, according as the metal is combined with more or less oxygen. It sometimes happens that the colour of the precipitate has a perfect resemblance to mineral kermes, or red sulphurated oxyde of antimony.

When the sulphure of tellurium is exposed on burning charcoal, the metal burns with a blue colour conjointly with the sulphur.

14. The infusion of gall-nuts, combined with the same solutions, gives birth to a flaky precipitate of an Isabella colour.

15. Iron and zinc precipitate tellurium from its acid solutions in a metallic state, under the form of small black flakes, which resume their splendour by friction, and which, on burning charcoal, melt into a metallic button.

16. Tin and antimony produce the same phenomenon with the acid solutions of the new metal.

The precipitate formed by the antimony proves, in a striking manner, that tellurium is not a disguised antimony, as has been supposed. A solution of tin in the muriatic acid, mixed with a solution of tellurium in the same acid, produced also a black and metallic precipitate.

17. The oxyde of tellurium, obtained from acid solutions by alkalis, or from alkaline solutions by acids, are both reduced with a rapidity resembling detonation, when they are exposed to heat on charcoal. It burns, and is volatilised, as has been already mentioned.

18. By heating for some time this oxyde of tellurium in a retort, it melts, and appears, after cooling, with a yellow straw colour, having acquired a sort of radiated texture.

19. Mixed with fat bodies, the oxyde of tellurium is perfectly reduced by the method above pointed out.

The ore of white gold of Fatzebay, *aurum vel metallum problematicum*, contains: tellurium 925.5, iron 72.0, gold 2.5: total 1000.0.

The graphic gold of Offenbanya contains: tellurium 60, gold 30, silver 10: total 100.0.

Ore from the mine known under the name of the yellow mine of Nagyag contains: tellurium 45, gold 27, lead 19.5, silver 8.5, sulphur one atom: total 100.0.

Ore from the mine known by the name of the mine of grey foliated gold of Nagyag contains: lead 50, tellurium 33, gold 8.5, sulphur 7.5, silver and copper 1: total 100.0.

XIX. *Some curious Circumstances respecting the two Elephants brought to Paris from the Hague. From a late French Journal.*

THE place for their reception had been long prepared. It is a spacious hall in the Museum of Natural History, well aired and lighted. A stove is placed in it to warm it during the winter, and it is divided into two apartments, which have a communication with each other by means of a large door resembling a portcullis. The enclosure round these apartments consists of rails made of strong thick beams, and a second enclosure, breast-high, runs round them, to keep the spectators at some distance, and preserve them from accidents.

The morning after their arrival these animals were put in possession of their new habitation. The first conducted to it was the male, who issued from his cage with precaution, and seemed to enter his apartment with a degree of suspicion. His first care was to reconnoitre the place. He examined each bar with his trunk, and tried their solidity by shaking them. Care had been taken to place on the outside the large screws by which they are held together. These he sought out, and, having found them, tried to turn them, but was not able. When he arrived at the portcullis, which separates the two apartments, he observed that it was fixed only by an iron bar, which rose in a perpendicular direction. He raised it with his trunk, pushed up the door, and entered into the second apartment, where he received his breakfast. He ate it quietly, and appeared to be perfectly easy.

During this time people were endeavouring to make the female enter. We still recollect the mutual attachment of these two animals, and with what difficulty they were parted, and induced to travel separately. From the time of their departure they had not seen each other; not even at Cambray, where they passed the winter. They had only been sensible that they were near neighbours. The male never lay down,

but always stood upright or leaned against the bars of his cage, and kept watch for his female, who lay down and slept every night. On the least noise, or the smallest alarm, he sent forth a cry to give notice to his companion.

The joy which they experienced on seeing each other after so long a separation may be readily imagined.

When the female entered, she sent forth a cry expressive only of the pleasure which she felt on finding herself at liberty. She did not at first observe the male, who was busy feeding in the second apartment. The latter also did not immediately discover that his companion was so near him; but the keeper having called him, he turned round, and immediately the two animals rushed towards each other, and sent forth cries of joy so animated and loud, that they shook the whole hall. They breathed also through their trunks with such violence, that the blast resembled an impetuous gust of wind. The joy of the female was the most lively: she expressed it, by quickly flapping her ears, which she made to move with astonishing velocity, and drew her trunk over the body of the male with the utmost tenderness. She, in particular, applied it to his ear, where she kept it a long time, and, after having drawn it over the whole body of the male, would often move it affectionately towards her own mouth. The male did the same thing over the body of the female, but his joy was more concentrated. He seemed to express it by his tears, which fell from his eyes in abundance.

Since that moment they have never been separated, and they occupy together the same apartment. The society of these two animals, their habits, their mutual tenderness, and their natural attachment, still excited by the privation of liberty, will furnish curious observations for the history of their species.

These two elephants, which are natives of Ceylon, were brought to Holland when very young. They are about fifteen years of age. Their height is seven feet and some inches. Their tusks, which are very short, have been
broken,

broken, but they will grow up again as they become older. The tail of the male hangs down to the ground: that of the female is much shorter.

XX. *Some Particulars respecting the late Embassy of the Dutch East India Company to the Court of Pekin.*

CITIZEN M. L. E. Moreau de Saint Mery has lately published, at Paris, an extract from Van Braam's Journal of the Embassy of the Dutch East India Company to the Emperor of China, in the years 1794 and 1795, one volume quarto, being the first. The second, accompanied with maps and engravings, is announced as about to appear.

The principal object of those who give an account of their travels to the public, ought to be to make known the usages, public and private manners, the legislation, arts, industry, productions, the temperature, commerce, religion, and government of those countries which they traverse.

Those of Citizen Van Braam have not been written according to this system; nor indeed could they, for the members of the embassy were hardly suffered to have any kind of intercourse with the natives. His work, as the title announces, is only a journal, containing an account of the different places through which the author passed in going from Canton to Pekin, and returning by the same route.

If this Journal, which seems to have been written only for the private satisfaction of the author, does not give an extensive and profound knowledge of China, it contains, at any rate, several details which may be useful to those who wish to collect information respecting this singular and interesting country.

There are three ways of travelling in China. By water, in vessels called yachts; by land, in palankins carried by men called coulis, or in small carriages made like wheel-barrows. The establishment of posting, and suspended carriages, are

unknown in that country. The horse, the most beautiful and useful animal in Europe, is despised there. Buffaloes, mules, and dromedaries, are the animals principally employed for transportation.

In no country does agriculture flourish so much as in China. This art is there beheld with almost religious veneration. On this subject there are treatises, brought to perfection by application and the experience of several ages : these treatises, suited to the soil of each canton, are deposited in the hands of the mandarin who acts as first magistrate ; and he takes care that the neighbouring farmers shall be made acquainted with, and turn to advantage, the lessons which these treatises contain.

Citizen van Braam speaks of the monuments which he frequently met with on his route, and which he characterises under the name of triumphal arches, and octagonal or hexagonal towers consisting of seven or eight stories. He does not explain the use of these towers, which appear to be in China what obelisks were among the Egyptians.

With regard to the triumphal arches, Citizen van Braam says that they are monuments erected to the memory of warriors who rendered services to their country, and sometimes to private citizens who signalised themselves by their virtues. Some have been erected also to young women and wives : to the former on account of their chastity, and to the latter on account of their fidelity.

If perpetual virginity could be made to accord with nature, it would be no great merit in China to devote one's self to it ; for the manner in which women are there treated, is not much calculated to awaken in young persons of that sex a desire of being chaste. Parents carry on a kind of traffic with their children. Those who are said to be of good birth give them in exchange for a large dowry, which they put into their own pockets : others sell them like merchandise, without caring what becomes of them. The wives of the rich live in perpetual confinement ; those of the second order

order are the servants of their husbands; and those of the lower class of the people are forced to take a share in the severe labour of the men, who treat them as we treat those animals which assist us.

The emperor is revered as a god. The power of the sovereign and of a high-priest are both united in his person. The same homage is paid to the edicts which he issues, the dispatches which he signs, and the presents which come from him, as are paid to himself. That is to say, the people prostrate themselves before a piece of paper, or silk, as they do when they are in his presence. The ambassadors were several times obliged to make ridiculous salutations before the remains of bad provisions, or pastry, which the emperor had sent them from his table as a mark of particular consideration and favour.

The court of Peking presents nothing striking. The most remarkable object is the wall by which it is surrounded. All the apartments are narrow and mean, and confusion prevails in all the ceremonies, which are conducted without any order whatever.

The entertainments to which the ambassadors were invited, consisted of a few breakfasts where the emperor was present. Some boiled meat, confections, pastry, a beverage called *samson*, and another called *bean-milk*, served up on tables around which the guests squatted down upon cushions, formed the chief articles at these morning collations.

It appears that the people of China make very bad cheer. The want of the pleasures of the table is not supplied by others. The Chinese spectacles consist only of a few feats of tumbling, and extemporary farces. And these spectacles even are not public. They are exhibited only in the interior part of the palace, and in the houses of some of the chief mandarins.

In this country there is no social communication among the inhabitants, who live insulated and confined to their own homes.

Though the ambassadors remained more than a month at Pekin, Citizen van Braam says nothing of the manners, commerce, or monuments of that city. This will not appear astonishing, when it is known that the members of the embassy, like those which preceded them from England, were confined to their hotel, as if they had been in prison; that they were narrowly watched; that the letters which they sent to some missionaries of their acquaintance were inspected at the post-office; and that they never went out in order to go to court, at three or four o'clock in the morning in the middle of winter, without being escorted by conductors. Such is the jealousy which the Chinese entertain of Europeans of every description, ever since a former emperor, expressing his surprise to a Spanish jesuit, who had less cunning than his associates, at the immense power and territory which the king of Spain had acquired in South America, was informed by the latter, that, having once gained an establishment in the country, missionaries were sent among the people to convert them to the Roman Catholic faith, after which their *subjugation* followed as a matter of course!

The people to whom Confucius preached his simple and sublime morality, the people who erected temples to that philosopher, ought to be rational in their worship: but they are vilified and degraded by the most absurd idolatry; their pagods are filled with idols of the most monstrous and whimsical figures.

If the Chinese, however, are idolaters, they are not intolerant; for Citizen van Braam speaks of a Christian to whom they have erected temples, and whom they style a saint.

XXI. *Chemical Experiments respecting different Methods of rendering Paper and the Writing on it indestructible by Fire.*

By Mr. L. BRUGNATELLI. From Crell's Chemical Annals for 1797.

OF all the substances I have tried, liquor of flint is that which, after a series of experiments, appears to me to be the most incombustible, and the most proper to secure paper from destruction by fire. I dipped the sheet of paper several times in the above liquor, fresh made, or, I daubed it several times over the whole paper with a hair brush, and dried it in the sun or in an oven. Paper prepared in this manner lost some of its softness, became a little rougher than before, and acquired a livid caustic taste. In other respects it was not different from common white paper. When this paper was laid upon glowing coals, it did not burn like common paper, but became red, and was converted to a coal, which however did not fall into ashes like the coal of common paper, so that it might therefore be considered as petrified paper. This coal, however, is exceedingly friable; for, when it is taken between the fingers, or pressed together in any manner whatever, it drops to pieces.

As the chemists consider incombustibility as one of the principal characteristics of saline substances, I made experiments with different kinds of salts, to try whether they would render paper incombustible, like this liquid siliceous potash, which is not a salt, but a combination consisting of two substances.

I took several sheets of common white writing-paper, and dipped each of them, in the same manner as I had proceeded with the above liquor of flint, in a particular salt, and observed how the different leaves withstood the fire when thrown into it. I shall here give an account of my observations as they occurred.

No. I. *Paper dipped in nitrite of lime.*—Leaves of paper which had been soaked in nitrite of lime distinguished them-

selves neither in whiteness nor smoothness from common paper. They burnt very readily, and were reduced much sooner to ashes than common paper.

No. II. *Paper dipped in nitrite of magnesia*.—Paper dipped in this salt appeared in nothing different from common paper. It burnt as soon as it was brought near a flame, and was converted to a very black coal, which however was not so friable as the first mentioned.

No. III. *Paper dipped in nitrite of ammoniac*.—Leaves of paper soaked in nitrite of ammoniac became again moist, after they had been well dried by the heat of the sun. They burnt in the fire and produced a very friable coal, which was afterwards entirely destroyed by the flame.

No. IV. *Paper dipped in muriate of lime*.—Leaves of paper which were dipped in this salt after it had been dissolved did not appear different, when dried, from other leaves not prepared in the same manner. When put in the flame they burnt very readily, and almost in the same manner as common paper, and were converted into a somewhat white, but highly friable coal.

No. V. *Paper dipped in muriate of barytes*.—Paper dipped in this salt did not seem changed in any of its external properties. It burnt when placed over the fire, and produced a very black shining coal, which was however somewhat less friable than the two last mentioned.

No. VI. *Paper dipped in muriate of soda*.—Paper dipped in muriate of soda acquired more consistence and became rough. It burnt in a flame, and the residue was a very black dense and shining coal, not more friable than the foregoing.

No. VII. *Paper dipped in muriate of potash*.—With muriate of potash the paper became somewhat rough, but in other respects no alteration was observed. It burnt without flaming, and was converted into a very black and friable coal.

No. VIII. *Paper dipped in muriate of ammoniac*.—Paper dipped in this salt underwent no visible change. When put into the fire, it burnt and was converted to a black coal; but when

when continued in the fire it became reduced to ashes like common paper, on account of the muriate which was destroyed by the heat. This paper, then, is in nothing different from common paper.

No. IX. *Paper dipped in sulphite of magnesia.*—Paper dipped in sulphite of magnesia acquired more consistence and more toughness than it had before. When held in a flame it took fire, and was converted into a friable coal of an ash grey colour; when it was however held longer in the fire, it was converted into some grains of a very white colour, which, by the chemical test, I discovered to be sulphure of magnesia.

No. X. *Paper dipped in sulphite of alumine.*—Paper dipped in dissolved sulphite of alumine, in which it was kept some time before it was dried, suffered no visible change, except that it was a little harder. When burnt, there remained a very black coal, which was more friable than that obtained from paper dipped in liquor of flints.

No. XI. *Paper dipped in sulphite of soda.*—Paper dipped in sulphite of soda shewed no visible change. On the fire it was converted into a very bright coal, which was destroyed by the flame of a candle. It became glowing, puffed itself up, and was totally changed into sulphure of soda, which with some acids had the smell of rotten eggs.

No. XII. *Paper dipped in sulphite of potash.*—Some leaves of paper which had been dipped in dissolved sulphite of potash, imbibed this salt exceedingly well; but it afterwards burnt in the fire, and was converted to a black coal, which soon after glowed, and was then totally destroyed. It however afterwards collected itself in small particles of sulphure of potash.

No. XIII. *Paper dipped in sulphite of ammoniac.*—Paper dipped in this salt assumed, after being dried in the sun, the moistness of the atmosphere. When burnt, the residuum was a black shining friable coal, which became afterwards annihilated like the former.

No. XIV. *Paper dipped in the acetite of magnesia.*—Paper dipped in this salt did not appear to be in the least changed. It burnt with a weak white flame like common paper, and was converted into a very friable ash-coloured coal.

No. XV. *Paper dipped in acetite of barytes.*—Paper dipped in this salt seemed, like the former, to have undergone no visible change. It burnt with a white flame, as common paper, and was at last changed into a coal of the like kind.

From the above observations it appears, that white salts do not deprive paper of its combustibleness like the liquor of flint. Some of them also, instead of defending it from the action of the fire, tend rather to accelerate its destruction, as, for example, the sulphites. The sulphureous acid which they contain loses with the inflammable body its oxygen, is converted into sulphur, and produces a little liver of sulphur, which is destroyed at the same time with the paper by the flames.

[*To be concluded in the next Number.*]

XXII. *Report made to the Council of the Mines in Spain respecting a new Wood proper for Dyeing, called Paraguan.*

By D. DOMINIC GARCIA FERNANDEZ, Inspector of the Mint. From the Annales de Chimie.

IN compliance with the orders of the Supreme Council of Commerce and the Mines, I undertook a chemical examination of a wood known in Guiana under the name of Paraguan. This examination I carried to such a length as I thought necessary for acquiring a knowledge of its nature, and of the advantages that may be derived from it in dyeing. I observed in the first place that the bark, the wood properly so called, and the leaves of the paraguan produce different colours. The leaves, however, do not merit much attention, as they communicate only a fading and not very agreeable colour. My researches have, therefore, been directed chiefly to the bark, as that part is the most important, and my observations

variations respecting the bark may be applied also to the wood ; for, though the latter produces a different colour, it exhibits almost the same phenomena as the bark.

If the bark be boiled in water, the coloured extract thence resulting, when exposed to the action of the sulphuric, muriatic and nitric acids, resists them much longer than an extract of brazil or logwood. The colour, after being destroyed by a combination of acids, may be revived by the means of alkalis.

Vinegar, lemon-juice, and tartar render this dye more brilliant, and communicate to it a fine rose colour, while these acids, on the other hand, destroy the colour of brazil and logwood altogether.

The feculæ of the bark of the paraguatan attach themselves and adhere to woollen, cotton, and silk. The colour is more brilliant on silk than woollen, and more brilliant on the latter than on cotton.

The same feculæ dried may be afterwards dissolved in alcohol, and communicate to it a tint similar to that obtained from cochineal.

By mixing alum with a highly concentrated decoction of the same substance a species of lake may be produced, but neither so lively nor so pretty as that obtained from cochineal by a like process.

The same decoction mixed with that of gall-nuts furnished me with a precipitated pigment of a weak rose-colour. An infusion of brazil or logwood, mixed with an infusion of galls, assumes a darker and browner tint; mine on the other hand became clearer by it, and assumed a delicate rose colour, or one somewhat similar.

It must indeed be acknowledged, that the dye extracted from the paraguatan has not a strength equal to that of cochineal. It is however superior to those of madder, brazil and logwood, since it resists vinegar, lemon-juice and tartar. Soap even does not destroy it so speedily as it does those of brazil and logwood.

The bark is attended with this advantage, that by employing
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it in certain quantities, and giving a suitable preparation to silk; we by these means may produce the various shades of rose and poppy colour, which can be produced only by the carthamus or safflower with alkaline mixtures, after a difficult process, tedious washings, and other embarrassing manipulations.

By examining the external form of a piece of the paraguatan, it appears to me to be the same tree as that which Francis Correal says he observed in the province of Popayan*, which is not far from Guiana. The same author relates that this tree is different from that of Brazil; that the trunk, which is the size of one's thigh, is thirty or forty feet in height; that its bark is full of longitudinal grooves; that the wood when stripped of its bark is of a beautiful red; and that the Indians employ the wood mixed with a red earth to dye the cotton which they use for dresses.

The colour extracted from the paraguatan does not resist the action of light: no colour indeed can stand that test. This colour, however, will stand much longer than that of brazil or logwood; but, on the other hand, these two trees furnish colouring matter in greater abundance.

I consider the paraguatan, therefore, as one of those valuable productions which America furnishes to Spain. It may be employed with advantage in the art of dyeing throughout all Europe. It is to be wished that search may be made for it in Popayan, and that some of the earth mentioned by Correal may be sent over to us. The governor of Guiana ought also to collect every information possible that may relate to the paraguatan, and to transmit it to us, as well as other specimens of the wood, with some of its leaves and flowers, in order that its species may be determined.

A knowledge of this wood begins to be extended, as I lately received a portion of its bark and of a red substance, which were brought from Guiana by an Englishman named Milnes. It is to be presumed that this substance is the same as that mentioned by Correal in his voyages.

* Voyages aux Indes Occidentales, 1722, p. 420.

INTELLIGENCE.

LEARNED SOCIETIES.

FRANCE.

*Prizes proposed by the National Institute, in the Sitting of
Germinal 15, (April 4th, 1798:)*

FIRST PRIZE.

VARIOUS artists have already presented several models and machines, destined for giving assistance to the highest stories of houses in cases of fire; but the Institute wishing to neglect nothing in an object of so much importance to humanity, has considered it as a duty to make it the subject of a prize.

It invites therefore ingenious men and artists to present either models or descriptions of machines, or to point out any means which may be used for giving assistance to every story of a house on fire. These means must be of such a nature, that they can be transported with facility to different quarters of a city or town; that they can be speedily erected before the house to which assistance is to be given, and that women and children may be able to descend by them from the highest stories without any danger. It is desired that these means may be as little impediment as possible to fire-engines, and to the manœuvres destined to check the progress of the flames. The competitors are requested to procure information respecting the practices followed at present, in different towns, in the like cases. They are requested also not to neglect to point out particular means which, though not generally used, may be employed in many cases; but these means must be simple, and easy to be put in practice.

The prize will be a kilogramme of gold.

The competition will take place on the 15th of Nivose, the 7th year (January 4th, 1799), and the Institute will proclaim

claim in the public sitting of Germinal (beginning of April) following, the piece which shall have gained the prize.

Second Prize. To determine by a great number of observations, the best and the most modern which can be procured, the epochs of the longitude of the apogee or node of the moon.

These observations must be at least five hundred in number.

The prize is a gold medal of the value of a kilogramme. The learned of all nations are invited to this competition, and they may write in any language whatever.

The works will not be received till the last day of Frimaire, 8th year, (December 21, 1799.)

The Institute will proclaim the piece which shall have gained the prize, in its public sitting of the 15th of Germinal following (April 4th, 1800).

Third Prize. To point out the earthy substances and processes proper for manufacturing earthen ware, capable of standing sudden transitions from heat to cold, and so cheap as to be within the reach of every class of citizens.

This art is still far from being carried to that degree of improvement so desirable for the public benefit, while some neighbouring nations who do not make porcelain, manufacture earthen-ware exceedingly useful, and superior to that made in France. The Institute requests the competitors to examine the composition of the best earthen-ware; the quality of those natural earths which may serve to form it, or that of the artificial mixtures which might be substituted for it; the manner in which these earths ought to be managed in order to give them the necessary properties; the art of baking; the degree of heat; the form of the requisite furnaces; and, above all, the processes proper for colouring and glazing without the oxydes of pernicious metals.

The competitors will remit to the Institute samples of the earths employed in their potteries, and the earthen-wares themselves which have been manufactured in them.

These samples of earth and pottery will be received till the first day of Messidor, the year 7 (June 18, 1799).

The Institute in its sitting of Vendemiaire 5th (Sept. 27) will proclaim the piece which shall have gained the prize.

Fourth Prize. To discover by accurate experiments what is the influence of the atmospheric air, light, water, and earth, on vegetation.

The prize is a gold medal of the value of a kilogramme. The works will not be received till the last day of Frimaire the 8th year (December 21, 1799), and the Institute will proclaim the piece which has gained the prize in its public sitting of Germinal 15, (April 4, 1800).

Class of the Moral and Political Sciences.

This class has proposed for the subject of the prize of the 6th year, the following question :

To determine the influence of signs on the formation of ideas.

The pieces received on this subject not having answered the conditions of the question, though several of them contained interesting researches, the class proposes again the same subject for the 7th year, and invites to the competition those, above all, whose first efforts have merited its attention.

The prize will be 5 hectogrammes of gold struck into a medal. It will be delivered out in the public sitting of the 15th of Nivose, the 9th year (January 4, 1801).

The works will not be received until the 15th Nivose of the 7th year (January 4, 1799).

The learned of all countries, the members and associates of the Institute excepted, are admitted to this competition.

Among the great number of authors who at all times have employed themselves on the human understanding, there are a few only who have paid attention to the means which might augment or direct its powers. Engaged only in researches respecting its causes, or occupied with describing its effects, they have for the most part been only able painters or obscure metaphysicians.

On the suggestions, however, of some men of genius, it has been found necessary to abandon enquiries into the first causes, and to direct our attention to the means of improving the understanding.

But the most powerful means of the progress of the human mind have been observed in signs.

The first philosophers who turned their reflections to the characters of writing, the accents and articulations of the voice, the movements of the visage, the gestures and different attitudes of the body, saw in all these signs only means, either established by nature or invented by men, for the communication of their thoughts.

A more profound examination shewed that signs were not merely destined to serve as a communication between minds. Notwithstanding the authority of some great men, who considered them as shackles to the justness and rapidity of our conceptions, these philosophers dared to advance that a man separated from any commerce with his fellows, would still have occasion for signs to convey the full meaning of his ideas.

In short, some have imagined that they observed in signs a much more astonishing service rendered to reason; that is, that the existence of the ideas themselves supposed the existence of signs, and that men would be deprived of all ideas if they were deprived of all signs.

So that they have judged signs necessary not only for the communication of ideas, for combining ideas newly acquired, and for forming new ideas, but still for having first ideas—the ideas which proceed more immediately from the sensations.

If a certain influence of signs on the formation of ideas is a thing incontestable and universally acknowledged, the case is not the same with the degree of this influence. Here opinions are divided, and what some consider as axioms, others treat as absurd paradoxes.

The Institute waits to receive memoirs, which by new researches, and new illustrations, may dispel the uncertainties
that

that obscure this important subject, and be proper to unite every opinion.

It presumes, that among the numerous questions which the fecundity of the subject of the prize may give rise to, the author ought not to forget to answer the following :

1. Is it true that sensations cannot be transformed into ideas, but by the means of signs? or, what amounts to the same thing, Do our first ideas essentially suppose the assistance of signs?

2. Would the art of speaking be perfect if the art of signs were carried to perfection?

3. In the sciences where truth is received without contestation, are we not indebted for this to the perfection of signs?

4. In those which furnish eternal subject for disputes, is not difference of opinion the necessary effect of inexactitude in the signs?

5. Are there any means of correcting signs badly made, and of rendering all the sciences equally susceptible of demonstration?

Medical Society.

THE Society of Medicine at Paris had proposed as the subject of the prize of 300 francs, to be adjudged this year, the following question :

“What are the advantages and inconveniences of the different methods of treating the aneurism?” But as this question was not sufficiently explained, the society decreed, in its public sitting of Floreal 22d (May 11), that the question should be proposed anew, and the prize adjudged in the public sitting of Floreal 22d, 7th year.

It proposed, in the same sitting, as a subject for the prize to be adjudged on the 22d of Brumaire, 8th year,

“To determine by accurate experiments what may be the influence of oxygen in the animal œconomy, and, above all, in the treatment of diseases both internal and external?”

Abstract of the Proceedings of the Class of the Physical Sciences of the French National Institute, from the 15th of Nivose last (January 4) till the 15th of Germinal (April 4).

THE papers presented to the Class of the Physical Sciences of the Institute, by its members and associates, during the above quarter, chiefly related to rural œconomy, the veterinary art, and chemistry.

Experiments lately made on horses, sheep, goats, and rabbits, prove, that these animals die speedily, and with convulsions, when they have eaten a certain quantity of the leaves or berries of the yew. Citizen Daubenton thinks that this tree is dangerous; that it ought not to be transplanted into countries which nature has preserved from it; and that it would be much better to destroy than to cultivate it.

Citizen Celly, in a memoir on the utility of employing analogy in the natural sciences, and on the application of botany to promote the progress of rural œconomy, endeavours to prove, that the properties of bodies being a consequence of their organization, the more relations there are between them, the more the uses for which they can be employed are approximated.

Citizen Gilbert shewed the necessity of subjecting all the operations of agriculture to comparative experiments, in order to enable the rural sciences to make that progress of which they are susceptible. He thinks it would be necessary to form rural establishments destined to enquire into the best processes, both for the cultivation of vegetables and the amelioration of the breeds of domestic animals.

Citizen Tenon presented a memoir, containing a comparison of the methods in which manducation is performed in man, the horse, and the elephant.

Citizen Chabert communicated reflections on a disease among horses, known under the name of immobility (*immobilité*), not yet described, and which has a great affinity with
that

that known among the human species under the name of the catalepsy.

An osseous tumour which arose in the ham of a horse, gave occasion to Citizen Huzard to make some reflections on the origin of that malady, and the means of curing it, when it is treated according to its principle.

Citizen Lelievre announced that he had lately discovered in France *sulphate of strontian* in a striated mass. It was found, at the depth of 15 or 16 feet, in a clay pit (*glaisiere*), which has been worked for some years, at Bouvron, near Toul.

Citizen Dolomieu shewed some of the *sulphate of strontian*, which he had brought with him from Sicily, and which, as well as the preceding, had been analysed by Citizen Vauquelin.

It is well known that the nitro-muriatic acid is the true solvent of gold, and that this metal may be recovered from its solution by sulphuric ether. Citizen Sage shewed a gold precipitate suspended between the ether and the nitro-muriatic acid, under the form of small threads or flakes, and at the bottom of the flask, in little brilliant masses, on which were observed triangular lamellæ, the elements of the crystallization of that metal.

Citizen Chaptal read a memoir on a new mode of manufacturing verdigrise. This new process, practised at Montpellier for some years past, consists in causing the residue (*marc*) of grapes to ferment, and of putting it in layers between plates of copper, to develop the metallic oxyd, called verdigrise.—This method is superior to the old one, as it is much easier, and attended with less expence, because it requires no wine.

Some experiments of the same chemist prove also that white lead may be made in the same manner.

The same chemist read another memoir on the acetite of copper, or distilled verdigrise. He gave an account of several experiments to oxydate copper with more advan-

tage, and to render it by these means soluble in the acetoous acid.

Citizen Berthollet communicated a notice on a particular acid which he had discovered, and to which he gives the name of the zoonic acid, because it is extracted essentially from animal substances. (*See page 68 of this Number.*)

Citizen Dolomieu read a memoir on the tourmalines found in Mount St. Gothard, the object of which was to examine, how far colour, considered as a character of stone, can determine its nature?

Lastly, the new experiments of Citizen Vauquelin, on the red lead of Siberia, and the new earth which he found in the beryl, or *aigue marin*, were the subject of another memoir.

HAMBURG.

THE society for promoting the arts and useful manufactures have proposed a prize of 40 ducats, to be given to the author of the best answer to the following question:

“What are the best means, confirmed by experience, to secure wooden work washed by the sea, such as sluices, buoys, signals for ships, &c. and even ships themselves, from being destroyed by the shell-worm (*teredo navalis*), which, as is well known, pierces through wood and hastens its decay?”

The society will consider that essay as the best, which proposes means of a cheap nature, known by experience to be effectual, and which are either as durable as the wood itself to withstand the effects of the waves and the ice, or can be renewed from time to time without inconvenience, and without injury to the works they are intended to preserve. All the means hitherto proposed for the like purpose, such as covering the wood with copper, lead, &c. are excluded from the prize; because these, besides being perishable in water, are liable to be stolen, and in many cases cannot be applied. No paper, also, can be entitled to the prize, unless the means proposed in it have been proved by experience

experience to be effectual. The society, however, will with thankfulness receive papers of this kind; the means proposed will be subjected to a trial of two years; and if they are then found to answer the purpose, a suitable reward will be adjudged to the inventor.

The essays on this subject, inscribed with a motto, and accompanied by a sealed note containing the name of the author, must be transmitted to the society before Christmas 1798.

HOLLAND.

THE members of the Teylerian second society at Haerlem have proposed the following prize question for the year 1799:

“What are the causes why most nations have made choice of metals, particularly gold and silver, as the representative signs of wealth and riches? What are the advantages of this circulating medium, so generally adopted, and what are the disadvantages connected with it? And can nothing else, equally durable, and attended with benefit and advantage, be invented in its stead?”

The premium for the best answer is a gold medal equal in value to 400 Dutch florins.

The answers in Dutch, Latin, French, English, or German, with a sealed letter containing the name of the author, must be transmitted to Teyler's foundation-house at Haerlem, before the first of April 1799; for the prize will be adjudged on the first of November, the same year.

The society have also announced, that as no answer had been sent in before the expiration of the fixed period to the prize-question of 1796, respecting the constitution and form of government of the Grecian republics, and their influence on the happiness or unhappiness of their citizens, they propose it once more in the following form:

“What influence has a republican form of government on the happiness or unhappiness of citizens? and, How far can this influence be explained and confirmed by examples

drawn from the history of the ancient Greek and Roman republics?"

The society require the answer to this question to be transmitted in the like manner before the first of April 1799, that the adjudication of the prize may be made also on the first of November.

ROME.

IN consequence of the 368th article of the Constitution of the new Roman Republic, the citizens who are to compose the members of the National Institute were nominated in April last by the French general. It is divided into two classes :—that of the sciences, mathematics and physic ; and that of philosophy, the belles lettres, and the fine arts. The first is subdivided into six sections—The mathematics, chemistry, anatomy, physics, natural history, and agriculture ; and the second into six sections also, viz. philosophy, history and antiquities, poetry and music ; the political sciences, grammar and eloquence ; the art of design,

ASTRONOMY.

Mr. HERSCHEL has lately discovered four new satellites to his planet ; so that there are now six. This discovery was made by a telescope of 30 feet, which he had constructed for the Observatory of Madrid. The first notice that Lalande had of this discovery was from Gotha, the Prince of which is fond of astronomy ; he laments, in a short notice which he published upon this subject, that for some years he has not received from Mr. Herschel any account of his discoveries in the heavens.

Paris, 30 Pluviose, (Feb. 18.)

Mercury and Venus have been observed to pass over the Sun's disk, under the form of black spots ; but no person ever before saw a comet in the like situation. Citizen Dangos, an able astronomer of Tarbes, on the 18th of January last
made

made an observation of this kind. He saw, during twenty minutes, a black body, round, and well defined, cross the face of the sun, and he remembers to have seen something similar in the year 1784.

LALANDE.

Paris, 2 Germinal, (March 22, 1798.)

The sun had been seen some days without any spot, but on the 29th of Ventose (March 19) there appeared a small one on its eastern limb. It had arrived there in the night-time, as well as that which was formed in the present decade. It will employ thirteen days and a half to traverse the sun's disk, according to the time of the sun's rotation, in regard to the earth, which I have determined to be 27 days 7 hours and 37 minutes. In comparing with each other the large spots visible by the naked eye in the years 1752, 1764, 1777, and 1778, I consider them to be the same spot, or at least formed at the same point of the solar globe, where there is probably a local cause which from time to time produces at the same place the same phenomenon.

LALANDE.

Citizen Messier, astronomer of the National Institute, about seven in the evening on the 23d of Germinal (April 11) discovered from his observatory a new comet in Taurus, near the Pleiades, and in the parallel of the principal star of that constellation, with which it was compared at 8h. 58m. 16sec. of true time; its right ascension being 49h. 19m. 47sec. and its declination 23h. 22m. 55sec. north. Next morning, the 24th, the comet was compared again with the same star, at 8h. 25m. 46sec. Its right ascension was found to be 50h. 52m. 55sec. and its declination 25h. 18m. 58sec.

This comet, which is small, round, and brilliant, has no tail, and cannot be seen by the naked eye. On the 25th its light was increased; which seems to shew that it is approaching the earth.

This is the 20th comet which Citizen Messier has discovered

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vered since 1758, and the 39th which I have observed. The number of the comets known now amounts to 88, according to the catalogue which is given in my *Astronomy*.

LALANDE.

Francis Lalande, nephew of the astronomer of that name, has lately carried to 45,000 the number of the stars which he engaged to determine.—An immense labour, which no astronomer before ever ventured to undertake, and which was a desideratum in astronomy.

Dr. Burckard, an able astronomer of Gotha, now at Paris, has calculated the orbit of the comet lately discovered. He finds that it passed its perihelium on the 3d of April, at 7 hours, in 3 signs, 12deg. 56m. at the distance of ,0487 from the sun: the inclination of its orbit is 45deg. 18m. and it intersects the ecliptic at 4 signs, 0deg. 44min.

M. de Lalande, in a letter which he lately wrote to Major von Zach, at Gotha, informs him, that the Turkish ambassador at Paris is remarkably fond of astronomy, and attends regularly the Lyceum, where he has a sofa appropriated for his own use. His interpreter Codrika has translated one of M. de Lalande's works into the Greek language. The Turks at present seem to apply with some attention to the cultivation of mathematical knowledge.—M. de Lalande says that a mathematical school has been established at Constantinople with four professors, and that the number of pupils amounts to fifty. Logarithmical tables are now printing in that city, with Turkish types.

EARTHQUAKES.

LETTERS received from Bencoolen, Tapoonooly, and Padang, of the 5th and 7th of March 1797, give the following relation of an earthquake that happened on the west coast of Sumatra on the 20th of February:

The vibratory shocks of this earthquake are stated, on competent authority, to have continued for three minutes,
and

and to have recurred at intervals, during a space of three hours, from its beginning, till the shock had completely ceased. At Padang, the houses of the inhabitants are almost totally destroyed, and the public works much damaged. The snow Padang, lying at anchor in the river, was thrown, by the sudden rise of the sea, upwards of three miles in shore, where she still remains. The number of lives lost at Padang on this melancholy occasion exceeded 300. Of these, some were crushed under the ruins of falling houses; some were literally entombed alive by the earth closing upon them; and others were drowned by the sudden irruption of the waters of the ocean. The effects of this awful convulsion of nature do not appear to have extended to the northward of Taponooly; as at that place little or no damage was sustained. It appears to have come from the southward, and is supposed to have extended as far as Bencoolen; but no accounts having been received at Taponooly or Padang, from the southward, between the time of the occurrence of the earthquake and the date of the letters, the extent of this calamity has not been ascertained.

At Natal, the residence of a subordinate of Bencoolen, very considerable damage was sustained, and several houses thrown down, but no lives were lost. It is however feared, when the particulars shall have been collected from the different quarters on the west coast, where the earthquake was felt, that the sum, both of lives and property destroyed, will be found much greater than yet apprehended.

A letter from Metz, dated Ventose 30, (March 20) states, that at six in the morning of the 24th a shock of an earthquake had been felt at Sarreguemines, Bliscatel, and other communes of the department of la Meurthe. No precise observations were made on its direction. It was so violent at Bitche that it raised up part of the arch of the bridge, so as to render it dangerous to be passed.

A fact which seems to explain this phenomenon is, that the circumference where it took place contains several mines
of

of naphtha. One of these burns continually, like the *sol-faterra* at Naples.

Some days before a flaming meteor rose from the earth, between Fey and Veron, three leagues to the south of Metz. Its disappearance was followed by a detonation which shook the atmosphere to a considerable distance around.

VOYAGES AND TRAVELS.

CITIZEN OLIVIER, who has been travelling through Persia by orders of the French government, writes from Constantinople, dated Frimaire the 18th last, that he has brought from Persia, Babylon, the deserts of Arabia, the environs of Aleppo, Cyprus, the mountains of Caramania and Asia Minor, more than two hundred seeds in good preservation; many medals of gold, silver, and bronze, Roman, Greek and Parthian; some mummies of children, and of the sacred birds of the Egyptians; some interesting manuscripts, &c. Proceeding then to the actual situation of Turkey, he concludes, from its depopulation; the great diminution of its revenues; the deserted state of its plains, which daily increases, by the oppression and impunity of the Pachas; the revolts of the latter; the mutinies and insubordination of the Janissaries, that this extensive empire is approaching to a sudden fall.

A gentleman of the name of Brown, who resided seven years in Abyssinia, is now in Egypt. He is said to have proceeded much farther west than Mr. Bruce, with whom he agrees in most points: he intends to publish an account of his travels, which no doubt will afford much information as well as amusement.

Frederick Horneman, the only son of a clergyman's widow at Hildesheim, a young man of an athletic constitution, a great mechanical genius, possessed of considerable knowledge and firmness of character, impelled with an insuperable impulse to a journey of discovery in Africa, is now on his way from Cairo over Caschna to Tombuctu. He travels at the expence of the African Association.

BOTANY, GARDENING, AGRICULTURE.

A LETTER from Mr. Anderfon, Director of the Botanic Garden of St. Vincent's, dated the 24th of December laſt, has been received by the Society of Arts, Manufactures, and Commerce, which brings very pleaſing accounts reſpecting the thriving ſtate of the bread-fruit-tree. In 1793, fifty young plants were carried from Otaheite by Captain Bligh. They were then from 6 inches to 2 feet high. They are now 30 feet and upwards, and the circumference of the ſtems from 3 to 3½ feet.

It was feared, when they were firſt carried over, that they would not have ſtrength to ſtand againſt the violent hurricanes of the Weſt Indies; but the wood is found, on the contrary, to be extremely tough, and well qualified to reſiſt the ſevereſt gulle of wind.

The bread-fruit weighs from 4 to 10lbs. each, and is in its greateſt perfection about a week before it is quite ripe. When baked, which is the beſt method of cooking it, it is equal, if not ſuperior, to bread. From its firſt appearance, it is three months before it is fit for eating.

The trees are propagated by fuckers, which ariſe in abundance.

The Society alſo received ſome biſcuit made from the fruit, which they agreed was an excellent ſuccedaneum for bread.

Some curious experiments, which promiſe important benefits to mankind, have lately been made by Sir Francis Ford, to determine whether oxygene, or vital air, has any effects upon vegetation different from common atmofpheric air. He found by repeated trials, that flowers, and other plants, ſprinkled with water that had been previously impregnated with oxygene gas, grew much more vigorouſly, and even diſplayed more beautiful tints than ſimilar plants on the ſame ground treated with common water. The water was impregnated by a very ſimple proceſs—Bottles filled with water

were

were inverted over a common pneumatic apparatus, and oxygene gas introduced till a third or fourth part of the water was displaced: the bottles being then stopped, were agitated for some time till it was believed the water had taken up all the gas that it could receive.

We know not whether the residuum of the gas has yet been submitted to any test, to determine whether it undergoes a change by being thus washed by the water; but, no doubt, the subject will receive that attention which it merits from those who have the means and opportunity of repeating and following out the experiments.

It appears to be a subject worthy of enquiry, what would be the best and easiest methods for impregnating water with oxygene? or, which would be perhaps still better, what would be the best substance to be thrown upon land to enable it, or the moisture it contains, to absorb the greatest quantity of oxygene from the atmosphere?

Some experiments have been lately made in the neighbourhood of Bristol, under the immediate inspection of one of the members of the Bath Agricultural Society, with respect to the culture of madder; the result of which is, that madder may be produced in large quantities in England, and sold to the dyers at a cheaper rate than that imported, being of a quality equal to that grown in Zealand. In 1756 the king of France issued an edict, exempting from land-tax for the space of 20 years (that is to say, in all fields newly broken up) all cultivators of madder in drained marshes and other waste and neglected grounds. In 1762 the Board of Agriculture held at Beauvais made it plain to all persons concerned in dyeing, that madder raised in that district, and used while the roots were fresh gathered, gave a finer tincture than the Zealand madder, and went further in the proportion of eight to five. In the same year it was ordered in council, that no tax, for the space of 20 years, should be levied upon grounds newly broken up, provided the said grounds had lain 20 years in an uncultivated state. In 1761 there

there were 13 societies existing in France, established under the patronage of government, for promoting agriculture; and these 13 societies had 19 co-operating societies belonging to them, whenever it happened that a district was too large to be effectually taken care of by one society. All packets and letters of correspondence to and from these societies were exempted from postage.

Paris, June 22, 1798.

CITIZEN BAUDIN, commander of *la Belle Angélique*, who, with several botanists and naturalists, was some time ago sent on a voyage of discovery by government, has just returned from America, and has brought with him the richest collection of living plants ever seen in Europe. He has brought home in all 3500 exotics, among which are several cabbage trees, cocoa-nut trees, and alligator pear trees (*laurus Persea*). Some of the trees are 25 feet in height, and from 12 to 15 inches in diameter. Besides the collection of living and dried plants, he has brought with him various specimens of wood, birds, insects, and many other objects of natural history.

Captain Baudin on his arrival attempted to enter the port of Havre, as being the most convenient for transmitting his collection to Paris, but was prevented by the English squadron which blockades that port. The English commander told him his orders were such, that he could suffer no vessel to entre Havre; but, in a very handsome manner, directed him to proceed to the east of Fecamp, the only place in the channel not blockaded by the division under his command.

MINERALOGY.

A VEIN of cobalt was some time ago discovered in the Wherry mine near Penzance in Cornwall, which, we are happy to announce, has turned out very rich; but as they have no person there perfectly acquainted with the process of smelting it, it is to be feared that its true value will never be fully known. It is to be lamented that there are few or no
 skilful

skilful mineralogists in Cornwall; and that we have no good *practical* work in the English language to enable them to apply to further use, what little knowledge they have acquired from working the rich tin and copper mines in that county. Kirwan's Mineralogy is an able scientific classification and brief analysis of the subjects of which he treats; but we want some popular works like those of Professor Klaproth. For want of proper books of this kind in the English language, there is reason to believe that many valuable mineral products are every day lost in Cornwall; for every substance that appears not to possess the characteristics of the tin or copper, of which they are in search, is thrown away among the rubbish. This was the case with the cobalt vein, when a gentleman of more knowledge than the proprietors happened to observe it.

WEIGHTS AND MEASURES.

IN the month of March last, Citizen Aubry presented to the Council of Five Hundred a work containing the proportions between all the measures possible, and a simple method to discover these proportions. This work is considered in France as a certain step towards an universal standard so much desired.

Sir George Evelyn Shuckburgh has lately laid before the Royal Society the result of many years application and study, upon the subject of a universal standard for weights and measures. He proceeds upon the principles of the late ingenious Mr. Whitehurst, and uses the identical instruments he employed. The mean measure is derived from the difference in length of two pendulums performing a different number of vibrations in a minute.

THE
PHILOSOPHICAL MAGAZINE.

JULY 1798.

- I. *Description of the Mechanism of a reflecting Telescope twenty-six Feet in Length, constructed near Kiel in Holstein, by Professor SCHRADER. From the Account, published in German, by the Professor.*

AN hexagonal frame ABCD, (Plate V.) formed of ten inch square beams, joined together, rests upon twelve strong posts driven into the ground. On the smaller hexagon of this frame stands the under part of the building *aaaa*, which rises to the height of fourteen feet, and is supported by braces or spurs. On the beams which compose the upper frame of this part of the building lies a horizontal wheel, 12 feet in diameter, which is made fast by means of iron screws. A small hexagonal cabin of the like diameter, and $7\frac{1}{2}$ feet in height, forms the moveable upper part of the whole building, to which is affixed the mechanism that serves for the motion of the telescope.

Through the middle of the small cabin arises a very strong axle *bb*, the upper part of which *b* may be seen projecting above the flat top of the cabin. At *c* the axle turns on a steel gudgeon which moves in a socket, fitted into a strong beam *dd*, moveable in a horizontal direction. This beam,

by means of iron wedges used as in the Dutch windmills, can be so elevated that the whole upper part of the building may be moved upon eight rollers placed above the horizontal wheel. A small vertical cylinder *ff* proceeds along the side of the cabin down to the horizontal wheel, and at the lower end has an eighteen inch wheel *g* with twelve teeth, which fit into those of the large wheel. The small wheel, to defend it from the injuries of the weather, is inclosed in a box. To the top of this small cylinder, which rises three feet above the platform, is affixed a cross-bar lever *xx*, and the cylinder has its point of motion in a collar at *b*, in which small rollers are applied to lessen the effects of friction. By turning the cross the whole cabin moves round its axis, and the tube of the telescope *II*, connected with it, is thus made to move also horizontally. The vertical movement of the tube, which was attended with considerable difficulty, is effected in the following manner: At the end of the beams *kk*, which project parallel to each other, on a level with the upper frame of the building, arise the inclined beams *mmn*, joined to the former by mortices at *o*, and morticed also at bottom into the uprights of the cabin. They are supported by strong braces, and, where necessary, are bound fast with iron screws. To prevent all lateral agitation, Professor Schrader placed at right angles on the two horizontal beams *kk*, and fastened to the cabin, another beam *H* of sufficient strength, each end of which projects five feet over the beams *kk*. From these ends arise two oblique beams *rz* and *si*, each of which is morticed as at *i*, a foot and a half below the bridle *ll*, and bound also with iron.

The mechanism of the movement of the tube between this hanging frame-work is similar to that of Herschel's telescope. Along the interior part of each side of the frame-work, from *n* to *l*, is a groove (represented in the plate by pricked lines), and a strong oblong rectangular frame moves in this groove by means of four small iron rollers fixed to the corners with screws. By the cross lines *vv* the place

place of the frame only is marked. In this frame the tube is made to move on a strong roller. At the upper end of the frame is suspended one box of a tackle of six pulleys, the second box of which is fastened to the cross beam *ll* of the hanging frame-work, and the rope *lp*, proceeding from the tackle, is wound round the cylinder of a horizontal windlass, the handle of which is in part visible at *tt*. The second resting-place of the tube is in a fork on the top of an iron rack *q*, by which the more accurate movement both vertical and horizontal is effected with the greatest ease. When the handle *tt* is turned round, the sliding frame together with the tube rises or falls, and a common spring catch applied to the windlass keeps the tube in that position to which it has been brought. To counteract the weight of the tube, which increases according to the perpendicularity of its position, the Professor fastened to the end of it a small tackle, the rope of which, carried over a pulley fixed to the cross beam *ll*, sustains a re-acting weight of 120 pounds. This weight acts only from the perpendicular situation of the tube to about that in which it is represented in the plate. The quick horizontal movement, which is effected by means of the cross-bar lever with the cylinder and horizontal wheel, requires a power of about forty pounds; so that the observer can, with great ease, turn the tube round the whole horizon, though the weight of the construction taken together amounts to about 12,000 pounds.

From comparing this description with the figure in the annexed plate, it will be seen that the gravity, both on account of the weight of the hanging frame-work and that of the tube, must incline too much to one side: it was found necessary, therefore, immediately after it was constructed, to devise the following counterpoise: The two horizontal beams *GG*, a foot square, which support the gallery *FF*, with the ladder that conducts to the platform, were made to project on a level with the bottom part of the cabin. The weight of the gallery and ladder caused a

lessening of the weight towards the opposite side; but, as this was not sufficient, the Professor made the horizontal beams to be covered with boards, by which means it acquired so much ballast that the centre of gravity of the whole top rested on the steel gudgeon *c*. The small balcony contains a seven-feet telescope ten inches in diameter, which the Professor suffers always to remain in the open air, and uses as a hand telescope. For the greater security, a strong iron rod, concealed by the wainscoting in the inside, is conveyed along the floor and to the top of the cabin. The lower extremity of this rod ends in two branches screwed to the floor, and the upper part rises one foot above the platform. On the top of it is stuck the key which serves for moving it; and by less than half a turn of this screw, the observer is enabled to prevent all agitation of the building, because the rod then presses with force against the surface of the horizontal wheel. Properly, however, there are three screws, forming an equilateral triangle, which effect this fastening, two of which in the cabin are very short, and the whole are so arranged, that it is necessary to move the long screw only on the platform. Thus, by its force, it as it were moves the upper platform from its level, and presses it a little, imperceptibly inclined, towards the two screws, which by their pressure on the horizontal wheel prevent all agitation.

The twenty-six feet octangular tube, constructed of boards which are prevented from bending by a number of knees applied in the inside, and which are made impenetrable to rain, is fitted to receive a speculum of from 19 to 20 English inches diameter. At present, however, it is furnished with one of only 14 Hamburg inches in diameter, having a focus of 26 feet, and which without the frame weighs 80 pounds. It is almost two inches in thickness, and towards the edge cast conical, so that the diameter of the polished surface is almost a quarter of an inch less than that at the back. This in the finishing and polishing is of the greatest utility.

utility. The great weight of the speculum requires that it should be always kept in the tube, and this renders necessary a peculiar apparatus not requisite in smaller telescopes. It is well known that large metalline masses acquire very slowly the temperature of the atmosphere. The consequence is, that specula are very frequently covered with the evaporation from the atmosphere, which condenses on them. If the composition of the metal be not good, the speculum soon becomes tarnished. The cause of this lies in too large a quantity of copper, which forms a component part of the mass, and therefore it must be combined with a sufficient quantity of tin. Edwards's composition in this respect is much preferable to all other mixtures. By more than forty experiments Professor Schrader discovered a very good mixture; and specula made of it were so excellent, that they might be exposed to considerable evaporation without losing much of their splendour. As in a close apartment no body can be tarnished, if a speculum be shut up during hot and moist weather the above inconvenience can be avoided. Professor Schrader has secured his speculum by a cover made of brass rings, eight inches broad, folded together. The centre screws, as well as the iron circle which keeps the speculum in its position, are properly fixed in these rings, and, by means of two capes with handles, which internally are lined with leather, or, what is better, with the skins of moles, the speculum is kept perfectly free from air.

The period of the day at which the speculum can be uncovered for use, depends on the length of time which it requires to assume the temperature of the atmosphere. A few experiments will here conduct to the proper regulation. A good rule for guarding against tarnishing is, to endeavour as much as possible to keep a continual draught of air in the tube. For this purpose, several small openings may be employed in such positions that the rain may not penetrate through them. A small stage for the purpose of getting at the speculum with more conveniency, is constructed near

the lowest step, to which the tube must be previously turned. A pole with a knee and a pulley stands by it, in order to take out the speculum occasionally. The reason why the under part of the building was constructed higher than necessary, was merely that a tube of 30 or 35 feet might be used.

II. *Description of the Javanese Swallow, which constructs eatable Nests; with an Account of the Manner in which the Nests are collected. From the Transactions of the Batavian Society in the Island of Java for promoting the Arts and Sciences, Vol. III.*

THESE small birds are of a blackish grey colour, inclining a little to green; but on the back to the tail, as well as on the belly, this blackish colour gradually changes into a mouse colour. The whole length of the bird from the bill to the tail is about four inches and a half, and its height from the bill to the extremity of the middle toe three inches and a quarter. The distance from the tip of the one wing to that of the other, when extended, is ten inches and a quarter. The largest feathers of the wings are about four inches in length. The head is flat; but, on account of the thickness of the feathers, appears round, and to be of a large size in proportion to the rest of the body. The bill is broad, and ends in a sharp extremity, bent downwards in the form of an awl. The width of it is increased by a naked piece of skin somewhat like parchment, which, when the bill is shut, lies folded together, but which, when the bill opens, is considerably extended, and enables the bird to catch with greater ease, while on wing, the insects that serve it for food. The eyes are black, and of a considerable size. The tongue, which is not forked, is shaped like an arrow. The ears are flat, round, naked spots, with small oblong openings, and are entirely concealed under the feathers of

the head, The neck is very short, as well as the legs and the bones of the wings. The thighs are wholly covered with feathers; and the very tender lower parts of the legs, and the feet themselves, are covered with a skin like black parchment. Each foot has four toes, three of which are before and one turned backwards. They are all detached from each other to the roots; and the middle one, together with the claw, is fully as long as the lower part of the leg. Each toe is furnished with a black, sharp, crooked claw of a considerable length, by which the animal can with great facility attach itself to crags and rocks. The tail is fully as long as the body together with the neck and the head. When expanded it has the form of a wedge, and consists of ten large feathers. The four first on each side are long, and, when the tail is closed, extend almost an inch beyond the rest. The other feathers decrease towards the middle of the tail, and are equal to about the length of the body.

The whole bird is exceedingly light and tender. Ten of them together weighed little more than two ounces and a half. The Javanese call it *larwit*; but those who live in the mountains, *berongdagæ* or *waled**.

There are two places in particular near Batavia where these birds are found in great numbers. The first, Calappa Nongal, lies about ten miles southwards from the city; the other, Sampia, is a little more distant towards the south-west; but they are both in that range of high land extending towards the sea, which is apparently different from the large ridge that extends over the whole island. Besides these there are also several other places in the same district, or at a greater distance from the coast, which either produce a few, or are carefully concealed by the Javanese to whom they are known.

The two bird mountains before mentioned, called by the Javanese caverns (*goa*), are insulated rocks, hollow within

* Vocrong in the Malay language signifies in general a bird.

and pierced with a great number of openings. Many of these openings are so wide, that a person can enter them with ease; others are attended with more difficulty; and some of them are so small, that nature evidently seems to have been desirous of providing for the security of these little animals. On the outside these rocks are covered with a multitude of strong tall trees of various kinds. The inside consists of grey calcareous stone and white marble. To the walls of these caverns the birds affix their small nests in horizontal rows, and so close that they for the most part adhere together. They construct them at different heights from 50 to 300 feet; sometimes higher or lower, according as they find room; and no hole or convenient place, if dry and clean, is left unoccupied; but if the walls be in the least wet or moist they immediately desert them.

At day-break these birds fly abroad from their holes with a loud fluttering noise, and in the dry seasons rise so high into the atmosphere in a moment, as they must seek their food in distant parts, that they are soon out of sight. In the rainy season, on the other hand, they never remove to a great distance from their holes, as has been often remarked, particularly in the government of Java, where there are some rocks situated very close to the shore. About four in the afternoon they again return, and confine themselves so closely to their holes, that none of them are seen any more flying either out or in, but those which are hatching.

They feed upon all sorts of insects which hover over the stagnated water; and these they easily catch, as they can extend their bills to a great width. Their most destructive enemy is a kind of hawk (*knikendief*), which seizes many of them as they issue from their holes; and which people, on that account, take great care to frighten away by shooting at them.

They prepare their nests from the strongest remains of the food which they use, and not of the scum of the sea or
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of sea plants*, as has been asserted. This seems the more probable, as it is known, from experience, that those birds which build their nests in the two rocks before mentioned have never been found on the sea-coast, and could not possibly fly thither and return again in so few hours, on account of the high intervening mountains, and the stormy winds that often prevail among them. The great difference in the colour and value of these nests proves that their goodness depends merely on the superabundance and quality of the insects on which they feed, and perhaps on the greater or less solitude of the place where they seek for nourishment. Those found on the territory of Calappa Nongal and Goagadja are exceedingly grey, and worth one third less than those produced in the territory of Sampia; and the latter again are not to be compared with an excellent sort which are every year imported from Ternate and Passier, or which are to be found on the surrounding islands, particularly to the east of Borneo.

These birds employ two months in preparing their nests; they then lay their eggs, on which they sit for fifteen or sixteen days. As soon as the young are fledged, people begin to collect the nests, which is done regularly every four months; and this forms the harvest of the proprietors of these rocks.

The business of taking down the nests is performed by men accustomed from their youth to climb these rocks. They construct ladders of reeds (*boschrotting*) and bamboos, by which they are enabled to ascend to the holes; but, if the caverns are too deep, they employ ship-ropes. When they have got to the bottom of the caverns, they place bamboos with notches in them against the wall, if these be sufficient

* This has been hitherto generally believed, and copied from one naturalist by another. Houttyn himself in his *Natuurlyke Historie*, vol. i. part v. p. 607, gives a description of the bird as well as of its manner of feeding, which is considerably different from the above.

in order to get up to the nests; but if they cannot reach them in this manner, they stand on the ladders and pull the nests down with poles of bamboo made for that purpose. There are also certain holes to which people can ascend by means of stages made of bamboos; but these are exceedingly few.

This employment, which is attended with great danger, costs the lives of a great many men, and particularly of thieves, while attempting to rob these caverns at improper seasons. For this reason, small watch-houses are everywhere built in the neighbourhood.

The mountaineers, who are those chiefly accustomed to this employment, never undertake their labour till they have slaughtered a buffalo, which is the usual preparation made by the Javanese for all their undertakings. On such occasions they mutter over a few prayers, anoint themselves with aromatic oils, and fumigate the holes with sweet-smelling substances, which, according to their ideas, are things all highly necessary. At the chief of these caverns in the island of Java, a particular protecting female deity is worshipped under the name of *Raton Laut Ridul*, or princess of the south sea. A small hut with a covered sleeping-place is there appropriated for her, together with various elegant articles of dress, which no one but a princess must approach; and every Friday when the nests are taken down incense is continually burnt, and the body and clothes of every one who intends to ascend the rocks must be exposed to it. The other Javanese are not so superstitious, and content themselves with much fewer ceremonies. To afford them light in the cavern, they employ torches made of the resinous gum of a large tree called *caret*, and the inner bark of the arek-tree.

The collecting of the nests continues no longer than a month, and, as already mentioned, may be repeated three times in the year. Some believe that it may be done a
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fourth time; but this is not probable, as all experienced people brought up to this employment confidently assert, that a nest as long as it remains entire is continually enlarged by the bird, or made thicker, until it is entirely deserted by her when it has become dry or hairy in the inside.

When the nests have been collected, no farther trouble is necessary than to dry them and clean them, after which they are put in baskets and sold to the Chinese. The price of them is variable, and depends on their whiteness and fineness. Some of them have a grey, and others a reddish appearance. Those of the best sort are exceedingly scarce. They are sold at the rate of from 800 to 1400 rix-dollars per 125 pounds. This high price, and the insatiable avarice of the Chinese, give rise to much dishonesty and thieving; especially as the Chinese make no ceremony of bribing the watchmen with money, opium and cloth; and this, even with the utmost vigilance, cannot be entirely prevented.

The two places above mentioned, Calappa Nongal and Sampia, belonged formerly to the Dutch East India company; but as the advantages arising from them were in part much lessened by the Javanese, and in part not well understood, government resolved, in the year 1778, to sell them by auction to the highest bidder, and received for them almost a hundred thousand rix-dollars, a sum far exceeding what was generally expected. Besides these, there are several other places of the like kind, in the above range of mountains, though of less importance. There are two or three also in the high land in the interior parts of the country, and several small ones which are kept concealed with great care. Three considerable bird mountains, Goa Daher, Gede, and Nangafari, are situated in the government of Samarang in Java; and these are washed by the sea, which forces its way so deep into the latter, that fish may be caught in it. In these places the nests are of an excellent quality; but it is exceedingly dangerous to collect them on account of the steepness of the

rocks and the violence of the surf, and therefore a suspended apparatus made of bamboos must be employed.

About 2500 pounds weight of these nests are collected every year in the island of Java.

There are bird caverns also in Bantam and the island of Sumatra; but the inhabitants of the former are so indolent, and the government so bad, that rice even is not sown, nor is any other article necessary for the support of life cultivated. The Chinese have never ventured to penetrate into the interior part of that kingdom, and have no intercourse with the mountaineers; so that little can be expected from that quarter.

The young birds are eaten both by the Javanese and the Europeans in India, but it is difficult to procure them. They are considered to be very heating. The nests, on the other hand, when they have been boiled to a slimy kind of soup, exposed in the night-time to the dew, and been mixed with sugar, are exceedingly cooling. The Javanese employ them therefore, with much advantage, in violent fevers. The author of this paper saw also that, when prepared as above, they were prescribed with good success for sore throats and hoarseness. This remedy, in all probability, has been borrowed from the Chinese, who, as a rich merchant of that nation who carried on a great trade with these nests assured the author, eat abundance of them during the winter, because sore throats are then very common in the northern part of that extensive kingdom, on account of people sitting so much over the fire.

But this nourishing and strengthening quality, so much extolled, the author was not able to discover, though he used a considerable number of these nests, prepared different ways, in order to be convinced of the truth. He caused them to be examined by able chemists; but nothing more could be observed, than that the solution presented a weak

gum

gum with a disagreeable taste, which perhaps might be of some use in slight indispositions of the breast.

These nests, therefore, are merely an article of luxury to ornament the tables of the rich. The Chinese are remarkably fond of them. After being soaked and well cleaned, they put them, along with a fat capon or a duck, into an earthen pot closely covered, and suffer them to boil for twenty-four hours over a slow fire, which they call *timmen*; and on account of this addition the whole dish acquires a more luscious taste.

The trade carried on with these nests was some years ago not so considerable, but of late it has much increased. The high price of them in China, which is still advancing, makes Batavia the principal mart of this commodity, which, as the company have now given it up, is employed very advantageously by the inhabitants to lessen the prejudicial exportation of specie.

That this species of swallow is not to be found in China is now sufficiently known.

Linnæus in his *Syst. Nat.* gives, as a distinguishing mark of the *Hirundo esculenta*, that it has white spots only on the feathers of the tail. The small birds in Java, however, which construct these nests, have spots neither on the tail nor on any other place. The tail feathers are entirely of one colour, blackish grey above, and a little brighter below.

Rumph says of his *capodes marinæ*, that the feathers of the tail were spotted, and that the breast also was speckled black and white.

Valentin, in his description of the small swallow which constructs eatable nests, mentions neither spots nor speckles, and says only that the belly was undulated white and black. If these are to be considered as essential differences, it will follow that there are two kinds of these swallows: one with a speckled breast and white spots on the tail feathers, and the other without spots or speckles. A third kind of these swallows would be those called *memos* or *boerongitams*. These

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also prepare their nests of eatable substances, but, on account of the number of small feathers and other impurities mixed with them, are not fit to be used. People therefore endeavour, as much as possible, to exterminate them, as they spoil the habitations of the better kinds. They are distinguished from the latter merely by being larger, and having the legs down to the feet covered by small feathers.

III. *The Process followed at Astracan to give to Cotton Yarn a Blue, Yellow, or Green Dye. From Neue Nordische Beyträge, by Professor PALLAS.*

THE manufacturers at Astracan, besides red cotton yarn, the process for dyeing of which has been given in the preceding number of this Journal, prepare also blue, yellow, and green, which they give out to be dyed by regular dyers. The process which they employ is briefly as follows :

The principal dye is the blue, which is employed both for cotton and silk. To prepare it, the indigo or blue dye-stuff is finely pounded, and dissolved in water by a gentle heat in large earthen jars, seven of which stand in brick-work over the fire-place, at the distance of about an ell and a half from each other. About two pounds are put into each vessel. Five pounds of the soda or *kalakar*, mentioned in the process for the Turkey red, finely pounded, together with two pounds of pure lime and one pound of clarified honey, are added to each: when these ingredients have been well mixed the fire is strengthened; and when the whole begins to boil the dye is stirred carefully round in all the vessels, that every thing may be completely dissolved and mixed. After the first boiling the fire is slackened, and the dye is suffered to stand over a gentle heat, while it is continually stirred round: this is continued even after the furnace is cooled, till a thick scum arises in the neck of each jar, and soon after disappears.

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The dye is then allowed to stand two days, until the whole is incorporated, and the dye thickens.

The dyers assert that with this dye they can produce three shades of blue, and that, as the dyeing particles gradually diminish, they can dye also a green colour by the addition of yellow.

When a manufacturer gives cotton yarn to a blue dyer, he first boils it at home in a ley of soda (*kalakar*), then dries it, washes it, and dries it again. The blue dyer lays this yarn to steep in pure water, presses out the superfluous water with the hands, and then immediately begins to dip it in the blue jar, often wringing it till it is completely penetrated by the dye. This first tint is generally given to yarn in such jars as have had their colouring matter partly exhausted. It is then dried, rinsed, and again dried; after which, it is put into the fresh blue dye, properly saturated; and, after the colour has been sufficiently heightened, it is dried for the last time.

For a yellow dye, the dyers of Astracan employ partly saw-wort, brought from Russia, and partly the leaves of the *kislar belge* or *sumach*. The process is as follows: The yarn is first boiled for an hour in a strong ley of soda; it is then dried, afterwards rinsed and laid wet to steep for twelve hours in a solution of alum with warm water. When it has been dried in the air, it is laid to soak several times in troughs with the dye which has been boiled thick in kettles from the above-mentioned plants, till it has acquired the wished-for colour, care being taken to dry it each time it is soaked. It is then rinsed in running water, and dried for the last time.

On this yellow colour a green is often dyed. After the yarn has been dyed yellow, it is given out to the blue dyer, who immediately dips it in the blue jars, the dye of which has been already partly exhausted; and if the green colour is not then sufficiently high, the operation is repeated, the yarn being dried each time.

IV. *Observations on a Junction of the Red Sea to the Mediterranean. From the Journal de Physique for 1798.*

IT is needless to attempt to prove of how much importance it would be to form a junction between the Red Sea and the Mediterranean. Every one is sensible that it might produce invaluable advantages in regard to the civilisation of Asia and Africa; the reciprocal commerce both between these two parts of the world, and between them and the whole of Europe; and particularly in regard to France; especially when it shall have joined the Mediterranean to the German sea, as I proposed in 1786, when I published *The Junction of the Rhone with the Rhine*.

It would be useless also to examine every thing that has been said by ancient historians, respecting the great works that may have been executed, or only undertaken, for that purpose, by the kings and other sovereigns or governors of Egypt, from Sesostris or Psammeticus down to Trajan or Adrian, since no traces or certain descriptions of them are remaining; and since so many efforts made so often, and in such various ways, from time immemorial, only serve to prove the great importance that has always been attached to this enterprise, even when it could have been attended only with a local or very limited utility in comparison of what it holds out at present.

It is however certain, that an able engineer, by examining the country with attention, would there discover remains sufficient to convey just ideas respecting the vague and contradictory accounts of the situation, the direction, entrance, and exit of these several canals. But all this would be of little benefit. He would doubtless perceive, that if some or a part of these works have been effaced or destroyed by the hand of time, or abandoned on account of wars, or through the policy or instability of governments, none of them were planned or executed in such a manner as to answer fully the
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end that ought to be proposed at present. They cannot, therefore, be assumed as models or helps for any new work of the same kind; which, however, as will here be seen, could be executed with much ease and simplicity, supposing the undertakers had entire and peaceable possession of the isthmus and western coast of the Arabic gulph, as well as of the course of the Nile, and all the intermediate country advancing a great way towards the south.

Without giving credit to a pretended higher level of the Red Sea than of the Mediterranean, which is not probable, we must, according to the account of all travellers, admit there periodical tides and accidental elevations, amounting from five to fifteen feet; and this is sufficient to prevent every plan of a communication between these two seas, constructed on a perfect level, and always navigable for the largest vessels, since an influx of waves so great would ravage it from the one end to the other, and certainly be followed by an ebbing so low as to render the Mediterranean higher and destructive in its turn. But what would oblige the undertakers to renounce this task is the impossibility of digging a long and continued bed, to the depth of twenty feet below the level of the two adjacent seas, in a district which no doubt rises much more above that level, and which is said to consist entirely of hills and downs of exceedingly moveable sand, where the construction and preservation of a canal would be like the labour of Penelope.

We must not, therefore, think of joining these two seas but by a river navigation for barks or boats drawing six or eight feet of water at most, and between two ports, such as Suez on the one side and Grand Cairo, Fostat or Boulac on the other, which seem to have been destined for that purpose, since their direct distance is only twenty-five leagues, and since the eastern branch of the Nile below Cairo is as deep as the sea itself at Damietta, Zan, &c.

But it is necessary not only to give the new canal the least length, but also the smallest elevation possible. But accord-

ing to every account, the nature of the ground will oppose the full execution of these two objects, and seems to show that they might thwart each other. The only method then is to weigh them both together, taking matters even in the worst light; and to determine the question I propose the following preliminary considerations:

1. The least elevation which the canal ought to have from one end to another, should be equal to that of the greatest tides or swellings of which the Red Sea is susceptible. The level of the canal would be thus fixed, and all the differences from the highest to the lowest rising of the sea would be counteracted by one or two locks, as it might be possible to counteract at the other end all the overflowings of the Nile, which probably rise higher, and which in that case would require flood-gates.

2. There are two other methods which might be adopted in the like case, but which would be far less advantageous. One of these, which would save the necessity of locks both towards the sea and towards the Nile, is, not to allow boats or other vessels to come from or enter the sea but twice a day at the times of the tides, and not to come from or enter the Nile but when it is at its greatest heights. But this would lay too great a restraint on commerce, particularly at Cairo, where the transportation of goods would not be possible but during two or three months: but still the level would become doubtful and variable, like all tides and inundations; and there would necessarily be alternate currents, which would render the water brackish and unhealthful, not only in the canal, but also in the Lower Nile.

3. The other method, in order to exclude locks altogether, or at least in part, would be, to depress more the bed and level of the canal, taking care to guard it at each end by the flood-gates, which would permit vessels to enter the sea or the river at the times of their greatest elevation. But, though this method might render the course of the navigation freer and less interrupted, it would not prevent the mixture of the
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fresh and salt waters. It would save nothing either in constructing or the labour of managing the locks: in short, it would increase in a prodigious degree the solid content of the excavations and the general expence of the works.

4. The smallest elevation which the canal ought to have would be fixed then by the greatest height of the waters either of the sea or the river. But in such an extent it is probable that several eminences might oppose this general level, and even in carrying the canal round these the labour would undoubtedly be increased. In short, it would be impossible to avoid the necessity of making the canal begin on a ridge or eminence; by which means it would descend by two inclined planes, one on the east towards the sea, and the other on the west towards the Nile.

5. In that case the question would be, to determine the *maximum* and the place of the elevation, which could be done only after a long examination of the spot, and an exact survey of the highest part of the ground, by means of levelling. The essential object of this examination will be,

1. To avoid both the sands which are to the north, and the rocks or mountains that abound in the south. 2. To find on the ridge of the latter that spot which would correspond best with the following conditions, viz. that the canal might be rendered as short and as little exposed to windings as possible; and that its point of departure should be so low that vessels might ascend to it by the fewest possible number of locks, and yet give occasion to as little digging as possible. 3. And as these three conditions will often be unattainable at the same time, to balance them, and to make them reciprocally give way and prevail in such a manner that the *medium* may ensure the most advantageous result in the greatest number of respects.

6. Having thus determined the summit or highest point of departure, with the length and depth of the canal, we may easily find, and without any doubt, the means of filling it,

and of feeding it abundantly by the waters of the Nile, by going up the river beyond Cairo as far as the spot where its general height is greater than the level already fixed, and from which it will be necessary to draw off on the right bank a large stream or branch of water, defended by strong gates against muddy water or extraordinary inundations, and to conduct it gradually in an inclination of fifteen or eighteen lines in a hundred fathoms, and to make it end by the shortest passage towards the western extremity of the point of departure. This, however, supposes that the mountains situated to the east cannot supply water in sufficient abundance and by a shorter passage, which would be extremely desirable, and which ought to be carefully examined; for it appears certain that the Nile has very little inclination below its cataracts, which are nearly two hundred leagues from Cairo; and consequently the place where the water is drawn off ought to be taken at a sufficient distance to be higher than the point of departure of the canal, however little it may have been established above the level of the highest tides and inundations.

7. According to the best and latest descriptions of that country, we may however believe that this point of departure will neither require deep excavation below the surface of the ground, nor a great elevation above the mouths of the canal, either at the Nile or the Red Sea; for it appears certain on the one hand, that the last of all the ancient canals, that ascribed to Amron the Arabian, was dug in a perfect level, and even open from one end to the other, proceeding from the Nile to Fostat; and on the other, that an ordinary rise of 16 cubits will be sufficient that the river may enter there at present, for a length of four leagues, traversing Grand Cairo. There is no reason then to doubt that this rise would proceed to the Red Sea, and would there make some fall, if the remains of the canal had not been filled up either by the hand of time, or by wars between those nations separated by the Adriatic.

8. It is probable then that this grand communication might be re-established by simple cleansing or by some amendment, but with sluices and other necessary works at both the mouths, that navigation might at all times be there possible, whatever might be the variable height of the waters in the river and the sea; the latter of which, notwithstanding what has been said on the subject, will be found constantly lower than the former even at the time of the highest tides. The highest risings of the Nile, therefore, which at Fostat are said to be from 20 to 22 cubits, must determine the general level of the canal, that is to say, the height of the locks necessary to descend towards each of its extremities when the waters are at their lowest, and also the distance and height of the place from which the water of the Upper Nile must be drawn off to feed this canal, coasting along the slope of the mountain as far as the northern cape or promontory of Mokattan, or from a basin raised about thirty feet above Grand Cairo. It would also be attended with the valuable advantage of fountains and great embellishments to that city, become the central mart or repository of the ancient world. Besides, it would be a powerful preservative against insalubrity and that contagion which so frequently afflict that immense city, on account of the drought and excessive filthiness which prevail there.

It may be readily seen, then, that this plan does not present nearly so many physical difficulties, and is not such an immense enterprise as some have imagined; since the distance either from Cairo to Suez, or to Colzoum, or to any other port more to the south or more convenient, does not exceed 25 leagues; for that of Suez seems difficult, and to be threatened with being speedily choked up at the point of the gulph which is the narrowest, and which becomes narrower every day—a new reason for abandoning a canal, though perhaps the shortest, which should proceed directly from Suez to the Mediterranean, particularly when we consider the impossibility of conducting so far, and amidst such

a foil, a stream from the Nile, which however would be indispensibly necessary to feed it, since it ought not, and even could not be dug to the bottom, or to the level of the two seas.

There is however one important remark still to be made, which is, that the present trade of Egypt with Asia is carried on merely by caravans, and by two different ways; one entirely over land across the isthmus and sands for 50 or 60 leagues, even to Syria; and another by a defile among the mountains of Upper Egypt, for 25 or 30 leagues only, from Cophtos to Coseir, which is a port of the Red Sea much easier of access than Suez, because the sea there is broader and much less dangerous. But as this defile seems to be favourable to a canal, which might be fed equally well and with more ease from the Upper Nile, and as that river is navigable to Cophtos as well as to Grand Cairo, there is every appearance that a canal in the latter situation, planned with the same care, would be more sure as well as more advantageous to the nation that might have the sovereign possession of Upper as well as Lower Egypt, especially as it is absolutely necessary that it should be sufficiently powerful to subdue the Bedquins, who infest the whole country, and who would soon render the canal of Cairo as impracticable as that of Cophtos,

V. Observations on the Organs of Vision in Bats.

By M. SPALLANZANI

THESE observations are extracted from a small work published by M. Spallanzani a few years ago, under the following title: "An account of some species of bats, which, when deprived of sight, perform their movements in the air as if they still saw: a faculty not possessed by other birds under the like circumstances." And the author says that he was led to them by some experiments which he made on
night

night birds. He let loose several birds in a chamber perfectly dark, and perceived that the bats flew about in it without any impediment, and neither rushed against any thing in the apartment, nor touched the walls with their wings. He at first imagined that they were conducted by some glimpse of light which he did not perceive, and on that account he blindfolded them with a small and very close hood. They then ceased to fly; but he observed at the same time, that this did not proceed from any deprivation of light, but rather from the constraint thence occasioned, especially when a hood of a very light texture was attended with the same effect.

He then conceived the idea of pasting up the eyes of the bats with a few drops of size or gum; but they still flew about in the same manner as if their eyes had been open. As this however was not sufficient, he pasted up the eyes of these animals with round bits of leather, and this even did not impede them in their flight.

That he might at length be certain of his object, he blinded them entirely, either by burning the cornea with a red hot wire, or by pulling out the pupil with a pair of small pincers, and scooping out the eye entirely. Not contented even with this precaution, he covered the wounds with pieces of leather, that the light might have no influence whatever on the remains of the organs which had been destroyed. The animals seemed to suffer very much by this cruel operation; but when they were compelled to use their wings, either by day or by night, and even in an apartment totally dark, they flew perfectly well, and with great caution, towards the walls, in order to suspend themselves when they wished to rest. They avoided every impediment great or small, and flew from one apartment to another, backwards and forwards, through the door by which they were connected, without touching the frame with their wings. In a word, they shewed themselves as bold and lively in their

flight as any other animals of the same species which enjoy the use of their eye-sight.

M. Spallanzani tried the same experiments with the same result on the eyes of the horse-shoe bat (*vespert. ferrum equinum*), the dwarf-bat, the great bat (*noctula*), and the bat of Buffon. M. Spallanzani is convinced that the other four senses still remaining to these animals cannot supply the want of sight; and he is therefore of opinion that a *new organ*, perhaps a *new sense*, which is wanting in the human species, may in them be put in activity by their being blinded. Professor Vassalli at Turin, Professor Rossi at Pisa, M. Spadone at Bologna, and M. Jurine at Geneva, repeated these experiments, and observed the same phenomena as those mentioned by Spallanzani.

VI. *Experiments on Bats deprived of Sight by M. DE JURINE.*

From the Journal de Physique for 1798.

THE experiments of M. Jurine were made only on the long-eared bat (*vespertilio aurilus*), and the horse-shoe bat (*vespert. ferrum equinum*). The bats were procured from the vaults under the fortifications of Geneva in the months of December and January. The author first obviates some doubts respecting the places where these animals reside in winter, as some of them have been found in a torpid state in the trunks of old trees during that season.

The author observes, that he found at the above season, and in the same vaults, abundance of moths (*phalænæ*) and crane-flies (*tipulæ*), and thinks he here discovers one of those wise dispensations of nature, by which other animals of more utility find a source of aliment when they could procure nothing in the atmosphere at that rigorous season.

The long-eared bat has six incisive teeth in the under jaw, three-lobed, and cut into the form of a heart. The upper has
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four, and unequal. The horse-shoe bat has none in the upper jaw, except two small ones in the membrane of the palate: the lower jaw is furnished with four. When the horse-shoe bat attaches itself to a wall, it contracts its body, and wraps itself up in its fur in such a manner that it might be taken for a black chrysalide. The long-eared bat appears less careful of itself, and first makes use of its hind feet, and then of those before, in order to affix itself to a wall.

The temperature of the vaults which served them for a habitation was between 50° and 57° Fahr. that of the external air between 27° and 30° . M. Jurine having exposed some of these animals to a temperature between 36° and 39° , several of them perished, and others fell into a state of torpidity; from which he was not able to rouse them by any touching, though a gentle current of air directed against them caused them to make a movement, by drawing back the whole body on the hind legs, and this they repeated as often as the insufflation was renewed. M. Jurine had before observed the same effect on mice. He remarked, however, that the approach of a candle agitated and awakened them, probably on account of the rarefaction of the ambient air. A violent agitation of the air by which they are surrounded makes them speedily take wing.

During the torpid state of these animals no movement is observed which can indicate that they breathe. A small horse-shoe bat, a large bat of the same species, and a long-eared bat were placed on a stove, and exhibited signs of life at different periods; but their inspiration and expiration were extremely irregular, particularly those of the long-eared bat. There is a striking difference between the position of these two species of bats when they fix themselves against any object. The horse-shoe bat hooks itself all at once, with its head down and its legs upwards; while the long-eared bat turns itself round quietly, in order to assume very often an oblique position.

The author then proceeds to the experiments which the illustrious Spallanzani undertook before, but in which great scope was still left for the imagination. The author seems to have found the desideratum which his predecessor left for those who might follow him in the same path.

He extended in an apartment several willow twigs three feet in length, at the distance of six inches from each other, and let loose two bats, which passed and repassed between them, without touching them at all with their wings, and which, when their flight was ended, always attached themselves to the same cornice. The author then cut out their eyes; during which operation, the long-eared bat suffered a considerable hemorrhage from the ocular orbits. Being let loose in that state, they still flew to the same interstices. These being barred up, they made choice of others, through which they passed several times, always avoiding to touch the twigs with their wings, and for that purpose they passed obliquely.

The long-eared bat sometimes stretched out its neck, and as it were made choice of that object to which it wished to attach itself; a custom which it had before it was blinded. It often applied one of its hind paws to its eye; collected the liquid which exuded from it, and then applied it with avidity to its mouth. These two bats lived a long time after they were deprived of sight. Two long-eared bats, the one blind, and the other having the perfect use of its sight, were let loose together. The blind one always followed its companion, even observing the smallest sinuosities of its course. The bat which saw, passed between the twigs with less delicacy than the blind one.

M. Jurine then extended a net with large meshes, after making a breach in it. The long-eared bat which saw, passed through it immediately; but the blind one stopped short, went all over the net, and, having found the breach, passed through without touching it, and then soon joined its

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companion, which it afterwards followed wherever it flew. Of what use then is sight to the bat, and what is the organ that supplies its place?

The author then imagined that the solution of this problem could be found only by anatomical researches. During the course of these, he found the organ of hearing very great in proportion to that of other animals, and a considerable nervous apparatus assigned to that part. The upper jaw also is furnished with very large nerves, which are expanded in a tissue on the muzzle.

M. Jurine then extended his experiments to the organ of hearing and that of smell. Having put a small hood on a long-eared bat, it immediately pulled it off, and flew. He stopped up its ears with cotton, but it freed itself in the like manner from that inconvenience. He then put into its ears a mastic of turpentine and wax. During the operation the animal shewed a great deal of impatience, and flew afterwards very imperfectly.

A long-eared bat, the ears of which had been bound up, flew very badly: but this did not arise from any pain occasioned by the ligature; for, when its ears were sewed up, it flew exceeding well. In all probability the animal would have preferred having its ears bound up to having them sewed. Sometimes it flew towards the ceiling, extending its muzzle before it settled.

M. Jurine poured liquid pomatum into the ears of a bat which enjoyed the use of its sight. It appeared to be much affected by this operation; but when the substance was removed, it took flight. Its ears were again filled, and its eyes were taken out; but it flew then only in an irregular manner, without any certain or fixed direction.

The ears of a horse-shoe bat, which had the use of its sight, were filled with tinder mixed with water. It was uneasy under the operation, and appeared afterwards restless and stunned; but it conducted itself tolerably well. On being blinded, it rushed with its head against the ceiling, beat the

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ozier twigs with its wings, and made the air resound with strokes which it gave itself on the muzzle. This experiment was repeated on other bats with the like effects.

The tympanum of a large horse-shoe bat was pierced with a pin (*trois-quart*). The animal appeared to suffer much from the operation, and fell down in a perpendicular direction when thrown into the air. It died next morning. The same effect was produced on piercing the tympanum of a long-eared bat with a needle.

The author then made very accurate researches on the difference between the organisation of the brain of these two kinds of bats, and, after a careful dissection, found that the eye of the long-eared bat is much larger than that of the horse-shoe bat, but that the optic nerve is proportioned to it. The outer part of the ear of the former is much larger than that of the latter, but the interior part is smaller.

The horse-shoe bat is indemnified for this difference by a greater extension of the organ of smell, as evidently appears when the external elevations and irregularities of its muzzle are examined. When it is about to take flight, it agitates its nose much more than the long-eared bat.

From these experiments the author concludes, first, that the eyes of the bat are not indispensibly necessary to it for finding its way; secondly, that the organ of hearing appears to supply that of sight in the discovery of bodies, and to furnish these animals with different sensations to direct their flight, and enable them to avoid those obstacles which may present themselves. The author also found on these animals a particular kind of fleas.

VII. *On the Antiquity and Advantages of Encaustic Painting, with an Examination of the Process employed in that Art by the Ancients. From a Treatise entitled Antichita, Vantaggi e Metodo della Pittura Encausta; Memoria del Ch. Sig. Giov. Fabbroni, &c. Roma, 1797. Quarto.*

[Concluded from page 31]

FROM what has been already said, it appears that encaustic painting is much better calculated than oil painting to withstand the power of time and the influence of those circumstances which destroy sooner any other kind. It affords this advantage also to the painter, that he can lay on an unchangeable white, which cannot be used in oil painting, as is proved by the fragment of a mummy above mentioned.

We are indebted in particular to Nardi, Borrichius, and Jablonski, for hints how to employ with advantage the Egyptian remains of antiquity; but one cannot help wondering, notwithstanding all the illustrations of these learned men, that they seem to be so little valued, and that mummies are now almost banished to apothecaries' shops, though they are often monuments of sculpture on account of the exterior cases in which they are preserved; of painting, on account of their clothing and bandages; and perhaps also of history, on account of the hieroglyphics which serve on them as inscriptions. In regard to the two first circumstances, mummies have not hitherto been sufficiently valued by those who neither trace out the progress of the human mind, nor are interested in enquiries respecting the infancy of the arts. With regard to the last point of so much importance, we often hear people say: Of what use is it to collect things of which we understand nothing? It may, however, be easily perceived that this is not the language of philosophy, whose penetrating eye sees farther, and which values every thing. Leibnitz considered it impossible to read and explain the Etruscan inscriptions; he even doubted whether they were

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characters.

characters. Without studying good collections and Etruscan monuments, could it have been possible to discover the alphabet of these ancient people? Without the repeated researches of travellers, could it have been hoped that Barthlemi would explain the Palmyrean inscriptions? Without possessing and examining the present fragment, or something of the like kind, could any one with certainty determine the remote period when the art of encaustic was practised, or discover the true method in which it was employed? But we shall allow every one to think on this subject as he pleases. Our academy requires facts and observations: any thing else does not merit its attention.

The first fact, which I think I have proved, is, that the Egyptians were acquainted with and practised wax painting.

The second is the better preservation of colours, and in particular of the white, by means of encaustic, notwithstanding the revolutions of many centuries.

The third is, that the matter of the Egyptian white colours is not metallic calces or oxydes, which at present are used in oil painting.

And the fourth, a deduction from the experiments made of the component parts of the ancient encaustic, which differ very much from those already made known.

Those who are acquainted with the accuracy and certainty of the method not long since introduced into chemical operations, will be convinced that in 24 grains of the encaustic painting, which I ventured to detach from the above-mentioned Egyptian fragment, in order to subject it to examination, the mixture of an hundredth part of a foreign substance would have been discovered with the greatest certainty; that the resin of Requeno must undoubtedly have been perceptible to me, and that the alkali of Bachelier and Lorgna could not have escaped the counteracting medium. But in this Egyptian encaustic I found nothing except very pure wax, though I varied my analysis in every known method. I must therefore conclude that modern learned writers, at least in respect

respect to this Egyptian mode of painting, were as far from the truth as the accounts of ancient authors appear to me precise and satisfactory; and that the encaustum with which formerly the fore part of ships and the walls of houses and temples were painted, was something different from soap or resinous crayons (*pastello di maslice*).

The basis however of the ancient pigments for the skin was perhaps formed of a waxy soap, with which they combined lake (*fucco*) and white lead; and hence perhaps arose the well-known common expression, which is still figuratively used, when people say that a face has *buona* or *cattiva cera*, according as the complexion appears healthful or sickly. But as those who at present prepare paints for the skin do not use that oil which the portrait-painters employ, it is not improbable that the ancients made use of one composition for paintings, and another for improving the natural complexion of the female skin.

I am well aware that it will be asked: In what manner can wax at present be rendered sufficiently liquid for the strokes of the pencil, if it be not converted into powder or soap? This question, in my opinion, can be fully answered from the words of an ancient author, and in the next place by experience.

Vitruvius in particular, book vii. chap. ix. expresses himself in the following clear manner:

“Those,” says he, “who wish to retain cinnabar on walls, cover it, when it has been well laid on and dried, with Punic wax diluted in a little oil (let this be well remarked); and after they have spread out the wax with a hair brush, they heat the wall by means of a brazier filled with burning coals (hence it is called encaustic painting), and then make it smooth and level by rubbing it with wax tapers and clean cloths, as is done when marble statues are covered with wax. The effect of this wax crust is, that the colour is not destroyed by the light of the sun or the moon.”

It here appears by these words of Vitruvius that the Romans, who copied the Grecian process, which the latter

borrowed from the Egyptians, mixed the wax with an oil to make it pliable under the brush; but no mastic, alkali or honey, as has been ingeniously imagined, and which some have thought might be employed with success. The difficulty now will be confined to point out in what manner this oil was employed. It does not appear that they used those fat oils which are commonly called drying oils; because they could have employed these as we do, without the addition of wax, which in such a case would have been entirely superfluous. Fat oils which do not dry would not have been proper for that purpose, as they would have kept the wax continually in the state of a soft pomade or salve. Besides, my experiments would without doubt have shewn me the existence of any oily matter.

With regard to essential or volatile oils, a knowledge of them is not allowed to the ancients, as the invention of distilling is not older than the eighth or ninth century, and therefore falls in with the period of Geber or Avicenna. But Herodotus speaks in a very clear manner of the distillation of asphalt, which was made at Susa; and I, who distinguish so much chemical knowledge among the Egyptians, cannot suppose them ignorant of so easy a process. In the temple of Vulcan at Memphis they had a school of chemistry, which flourished there for a long time, as we are told by Zosimus Panopolitanus, Eusebius, Sinesius, Albufaragius, &c. In order to use wax in their encaustic painting, it is certain that they must have combined it with an ethereal volatile oil, of which no traces should afterwards remain; because this was required for the solidity of the work, and because I actually found this to be the case in the fragment which I examined. But though they might be unacquainted with the art of separating ethereal oils from the many substances which they contain, they certainly were acquainted with a very volatile thin oil produced by nature, and which in various places issues from the earth, but probably not in Greece, as I found reason to conjecture from the following observations:

tions. Strabo and Plutarch relate that the people of Ecbatana, in order that they might exhibit a pleasing spectacle to Alexander the Great, shewed him a flaming stream, by sprinkling rock-oil in the streets of a village, and then setting fire to it. They also rubbed over with naphtha a naked boy, and then setting fire to it in the like manner caused him to run about in a bath. These people then were acquainted with naphtha, which issued from the earth in that district; but it was not known in Greece, at least to the common people, as it never was seen by them under the like circumstances. This ethereal oil was used, in my opinion, to render wax fit for painting; and it is natural to suppose that it would be first employed for this use where it was first known. It appears to me that the Greeks, as was the case with many other things, and as the above-quoted authors say, learned encaustic from the Egyptians, as the latter learned it perhaps from the Assyrians or Chaldeans. We know that Lyfippus wrote expressly under one of his pictures: "Painted in encaustic;" which he would not have done, had not this kind of painting been new or a secret in Greece.

Naphtha is an ethereal oil much lighter than sulphuric ether itself, as I found, contrary to common opinion, by my experiments. It is an exceedingly volatile oil, which entirely flies off and evaporates without leaving a single trace of it behind. On account of this property naphtha is used, as is well known, to copy signatures and manuscripts, by rubbing it over the paper to which it may be requisite to transfer any writing, as it makes it perfectly transparent. The paper then becomes opaque and white as before, after the naphtha has evaporated. Such in all probability was the case with the oil, which Vitruvius does not specify, but which, as he says, was combined with the wax. It was for this reason that I found no oil in the Egyptian wax painting when I examined it. We have therefore discovered the real mixture used for the ancient encaustic painting.

But, to bring my assertions to greater certainty, it was necessary not only to prove the absence of every foreign matter in the above-mentioned encaustic fragment by means of an accurate analysis, and to form some conjecture what kind of oil must have been combined with the wax, but it was necessary also to search for an imitation of it synthetically; and I had the good fortune to meet with a favourable opportunity of gratifying my wishes in this respect.

In the year 1785 my worthy friend Gultenbrum, an eminent Saxon painter, now in London, resided at Florence. I prepared for him a solution of Venetian wax in highly purified naphtha, and desired him to mix up with it the colours necessary for a painting. He immediately complied with my request; and we were both astonished, as well as all our friends, at the high tone which the colours assumed, and the agreeable lustre which the painting afterwards acquired, when it had been rubbed over with a soft cloth. I observed that, in following this process, the artist can determine the effect of the colours from their appearance on the pallet. This is not the case when the wax is combined with alkali, gum, or mastic, by which the pigments have a different appearance under the pencil, from that which they ought to have on the painting; because the painting, until it has been dried, heated, and varnished, appears muddy and obscure. At this period I had only conjecture in my favour respecting the composition of encaustic; but the result of the above trial, and, still more, my examination of the Egyptian fragment, so often mentioned already, freed me from all doubt.

I made another preparation of the like kind for that celebrated painter Ademello, by combining a quantity of the common spirit of turpentine (*acqua regia*) with wax, the good effect of which was also extolled by that artist. The purpose for which at present I would apply a preparation of this kind, is to daub over some of those beautiful paintings in fresco by Giovanni da San Giovanni, to be seen in the court

of an elegant villa near this city, which in my opinion would certainly preserve them from that decay through which they are advancing with rapid steps to destruction; for it appears from the words of Vitruvius, that encaustum was used in the time of the Romans to cover parts which had been already painted either with water colours or in fresco. I judge, from the analogy of effect, that this was the substance with which Apelles daubed over his paintings, and which, according to Pliny, made them appear as if covered by a thin plate of talc or transparent selenite, and gave the colours a wonderful softness. In the ancient cedar oil I can distinguish only the more modern *acqua ragia*, or spirit of turpentine; consequently that, or naphtha, was the oily matter which the ancient painters must have used for their encaustic works.

As experiments made both by analysis and combination were favourable to my idea, I flatter myself that I have approached nearer the truth than the preceding celebrated writers, whose researches were indeed highly useful and meritorious, and among which the illustrations of the learned Requeno deserve much praise. Should this be granted, I shall think myself well rewarded for my trifling labour; and nothing remains but to express a sincere wish that I may see the above method extended to all those purposes to which it was applied by the ancients, that is, to preserve paintings in water colours, or on plaster, and sculptured pieces of marble. Were our public statues covered with encaustum, as was the case formerly, according to Vitruvius and Juvenal, the dark moss (*lichen*) would not adhere to their pores, which disfigures their whiteness, and renders them black; and to which the attracting of oxygen by carbon may perhaps somewhat contribute. Were paintings *a fresco* and *a tempera* covered with wax in this manner, Florence would not have lost so many masterpieces by Giovanni and Andrea, which it once possessed. Lastly, were this plastic varnish used, after the method of Apelles, to give equality to the tone of the colours, and to

preserve our oil-paintings, many valuable pieces would be guarded from the destructive influence of the light and atmosphere, which change every thing; insects would be protected from being spotted with dust, which greatly injure their tints; and in particular we should prevent that damage which the common resinous varnishes occasion, though with slow steps, as these varnishes not only become black of themselves with time, but, as they contract in drying, and, becoming hard, they produce rents and cracks, and consequently bring the painting, which it is wished to preserve, sooner to destruction. Resinous varnishes are naturally stiff and unpliant, and the materials on which most new paintings are found are hygrometric substances, which contract or expand in proportion to the dryness or moisture that prevails in the atmosphere. If it be true, as Oberlin observes, that the varnish (*vernice di moriconi*) has rendered many beautiful paintings scaly, which were taken from the ruins of Herculaneum in good condition; what destruction must it not occasion in paintings on wood and canvas! Giuseppe Piazenza also makes a very pathetic remark on this circumstance. But I do not say this with a view to offend those judicious and meritorious persons who go to work with prudence and skill, as I have no other object in my observations, than to place in a proper light the antiquity and superiority of wax-painting.

VIII. *An Account of the "New Method of performing and facilitating the Business of divers manufacturing and economical Processes," for which a Patent, dated 24th June 1795, was granted to "SAMUEL BENTHAM, Esq. of Queen's-square, Westminster."*

EVER since the days of Bacon, the philosophers of Europe have employed themselves in determining, by actual experiments, the physical properties of matter, and the laws to which

which it is subject; not merely to gratify a harmless and laudable curiosity, but with the avowed intention of reducing to a rational and solid system of principles, the various arts, manufactures, and economical processes which, before that period, depended almost wholly upon chance or caprice.

To the result of philosophical experiments we owe the present advanced state of science, and the many improvements which have been introduced into the manufactures of Britain, and have brought them to the high state of perfection they have attained. Has Mr. Bentham, in the patent under consideration, added to the number of physical facts before known? Has he discovered any new principles to entitle him, as a discoverer, to enjoy for fourteen years an exclusive monopoly of the arts to which they apply? No such thing. Mr. Bentham has discovered what all the world knew before—what may be found, in various forms, scattered through the pages of thousands of volumes; namely, that it would very much promote arts and manufactures, if means could be devised to enable us to apply, in the large way, all the facts that have been determined by philosophical experiment. Yes, reader, the learned of all countries have been indefatigable in their various pursuits for these last two centuries, only to furnish materials for the exclusive advantage and emolument of Mr. Bentham. But he shall be allowed to speak for himself.

Every one knows, that a patentee must lodge in the proper office a specification, describing his invention in so full a manner that, at the expiration of his term, the public may be able to enjoy the benefit of the discovery. The present patentee, in compliance with this requisite, says, “I the said Samuel Bentham do hereby declare, that my said invention is described in manner following; that is to say, my invention consists in the *idea* of applying to the purposes of art and manufacture, in *the large way*, the practice that has been *so long in use*, of extracting and excluding the air in *the way of philosophical experiment.*” He then proceeds to tell

us, that "air is either *known* to be, or suspected of being, an obstacle to art and manufacture, in a great variety of ways;" but it would be insulting our readers to enumerate those he points out, as they must be as well acquainted with them as Mr. Bentham himself. We shall only observe in passing, that, as he admits the fact to have been known *before*, it appears odd that he should call the *idea* his invention.

He then proceeds to exemplify the uses that may be made of *his* invention, in preserving substances animal and vegetable from putrefaction. It was known, before Mr. Bentham was born, that such substances might in some degree be preserved for a long time *in vacuo*: but perhaps Mr. Bentham has found out some new way of producing a vacuum, and therefore is entitled to the exclusive use of that method?—No! He says the air must be extracted from the vessel or chamber by "an air-pump, or *otherwise*;" but the other ways he has kept to himself. Mr. Bentham supposes that, in the practice of potting solid substances, the fat, which in a melted state is thrown round them, acts "in good measure" by excluding the air. It is *partly* true; but it performs another work which his vacuum would entirely destroy—it prevents the escape of the juices.

"Many of the changes," says the patentee, "to which bodies are subject in point of colour, are known to result from the action of the air. An exhausted chamber affords the means of preserving them from all such changes, for any length of time." This was known long ago; but we shall suggest one use to which those may apply it, who shall first purchase permission from the patentee. Such as wish to preserve the colours of their clothes from being injured by the action of the air, may get an air tight-case made for themselves to walk in—the bottom part terminating in a pair of boots. After they have inclosed themselves, let their servant, "by an air-pump or otherwise," extract the air, "care being taken at the same time to exclude the light, when the presence of that element also is found to influence
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the result." This process, excepting the boots, has been often tried, "in the way of philosophical experiment," upon mice and other small animals; but, having never yet been applied in "the large way," comes fairly within the right of the patent.

"Distillation;" "effectuation of contact;" "intromission into tubular or other cavities," (for instance, filling a thermometer, as if such a thing had never been performed in the same manner before Mr. B. hit upon the idea;) "impregnation;" "transmission and percolation;" "mixture, viz. of fluid masses with powders, or heaps of small-sized bodies;" "regulation of heat;" and "exiccation;" are all enumerated and exemplified at great length, as processes in which the exclusion of air would be an advantage: but we shall not abuse the patience of our readers by detailing the particulars*.

"The vacuum chamber may be of the size of a large room:—to enable the operator to see the processes, it may have glass windows to it, but the glass must be thick." Indeed it must! "to enable it to resist the pressure of the atmosphere." "For the accomplishment of such a *variety* of purposes," says Mr. B. "a *variety* of operations may respectively require to be performed; to some of which, a *variety* of machinery, and that more or less complicated, may be necessary: as, in all or most of these instances, the source of motion will be exposed to the external atmosphere, while the subject to be operated upon will be in the vacuum chamber, the most commodious means of transmitting the motion from the one of these situations will, on this account, be an object of attention." Our readers may surely expect something new in the way of invention after all this pomposity. We are now told that "the methods *already in use* in the way of experiment, such as the collar of leathers, will in

* Those who wish to be informed more fully, may see a copy of the specification in The Repository of Arts and Manufactures, vol. vii.

general be found sufficient, however large the scale! A spindle sliding in such a collar gives rectilinear motion;" wonderful! "A spindle turning round on its axis gives circular motion;" wonderful!! "From one or other of these two, or indeed from either of them, any other motions may be produced at pleasure:"—and if you cannot, from this description, frame a parcel of Androides able to work in your vacuum chamber, in packing beef and butter into casks, gilding and plating metals, casting images, glueing boards together, filling thermometers, and performing every thing you can wish, it is because your scull is a vacuum also.

Whoever can discover the means, whether by an air-pump or otherwise, to make with facility such large vacuums, and can contrive the *jack in the box* who is to perform the various operations required, may do it without consulting with this patentee, whose *invention consists in an idea* that should others contrive such machinery, he could prevent them from using it without paying him for the privilege. It is however a mistake, founded upon another, that what becomes an art or manufacture ceases to be philosophical; when the fact is; that an art is only perfect in proportion as it is strictly so. He labours under another error, when he believes that the difference in the scale, on which any process may be carried on, will furnish grounds for a patent! *Great and small* are merely relative terms, and absolutely mean nothing in themselves—1000 is a great number when compared with unity, but when contrasted with 1,000,000 it becomes a small one.

The duty we owe to the public calls upon us to point out the faults as well as the merits of Patent Inventions; but when we see, as in the present instance, an unjust effort made to monopolize the fruits of the accumulated sagacity of those who labour for the benefit of their fellow-creatures in general, it lays us under a double obligation to expose the impudence of the attempt.

IX. *On the Theory of the Structure of Crystals, by the Abbé HAUR.*
 From Vol. XVII. of the Annales de Chimie.

[Continued from Page 46.]

2. *Various Examples of Decrease on the Edges.*

DODECAEDRAL Sulphure of iron or martial pyrites (*fig. 19, Plate VI.*) *Pyrites ferrugineus dodicaedres.* Daubenton. *Tab. Miner.* edit. 1792, p. 29. De l'Isle, *Crystallographie*, t. ii. p. 224. var. 16.

Geomet. Charact. Inclination of any one of the pentagons, such as DPRFS to the pentagon CPRGL, having the same base PR $126^{\circ} 56' 8''$. Angles of the pentagon CPRGL, $L = 121^{\circ} 35' 17''$; C or G = $106^{\circ} 35' 57'' 30'''$; P or R = $102^{\circ} 36' 19''$.

Let us again conceive a cubic nucleus, the different edges of which are so many lines of departure to the same number of decrements, taking place at the same time in two different ways, that is to say, by the subtraction of two ranges parallel to the edges AB, CD (*fig. 7, Plate II.**), and of one range parallel to the edges AD, BC. Let us suppose also that each lamina, being in thickness equal only to a small cube of the side AB and CD, is equal to double the side of AD and BC. This disposition, in regard to the decrements proceeding from the lines DC, BC (*fig. 7*), is represented by *fig. 14*. In this hypothesis it is evident that on account of the more rapid decrease in departing from DC or AB, than in departing from BC or AD, the faces produced in the former case will be more inclined to the plane ABCD, while the faces produced in the latter will remain as it were behind; so that the pyramid will no longer be terminated by a single cube E (*fig. 12*), which, on

* All the figures below 14 referred to in this article will be found in plate II of the preceding number, and all above it in plates VI and VII of the present number.

account of its extreme minuteness, appears to be only a point, but by the range of cubes $M N S T$ (*fig. 14*, Plate VI.) which, supposing these cubes to be almost infinitely small, will present the appearance of a simple ridge. By a necessary consequence the pyramid will have for faces two trapeziums, such as $D M N C$, resulting from the first decrement; and two isosceles triangles, such as $C N B$, which will be produced by the second decrement*.

Let us suppose, moreover, that, in regard to the laminæ of superposition which arise on the face $B C G H$ (*fig. 7*, Plate II), the decrements follow the same laws, but by cross directions; so that the more rapid of the two may take place in proceeding from $B C$ or $G H$ towards the summit of the pyramid, and the slower in proceeding from $C G$ or $B H$ towards the same summit. The pyramid resulting from these decrements will be placed in a direction opposite to that resting on $A B C D$, and will have the position exhibited *fig. 17*, where it is seen that the edge $K L$, which terminates the pyramid, instead of being parallel to $C D$ like the edge $M N$ (*fig. 14* and *15*), is, on the contrary, parallel to $B C$. We shall then conceive what ought to be done in order that the pyramid which will rest on $D C G F$ (*fig. 7*) may be turned as represented *fig. 16*, and may have its terminating edge $P R$ parallel to $C G$ (*fig. 7*). I shall say nothing of the pyramids that will rest on the three other faces of the cube, because it is evident that each of these pyramids ought to stand like that which arises on the opposite face.

But as the decrements which produce the triangle $C N B$ (*fig. 15*) make a continuity with those from which results the trapezium $C B K L$ (*fig. 17*), these two figures will be in the same plane, and will form a pentagon $C N B K L$ (*fig. 18*).

* Here the face which corresponds to $A B C D$ (*fig. 7*.) has 25 squares on each side, as may be seen *fig. 14*. and the structure of the pyramid in question may be imitated artificially by observing the order and number of the cubes represented in the same figure.

For the same reason the triangle D P C (*fig. 16*) will be on a level with the trapezium D M N C (*fig. 15*); and by reasoning in the like manner in regard to the other pyramids, it will be conceived, that as the six pyramids have for their whole faces twelve trapeziums and twelve triangles, the surface of the secondary solid will be composed of twelve pentagons, which will correspond with the twelve rhombuses of *fig. 5*; but with this difference, that they will have other inclinations. This solid is represented alone *fig. 19*, and with its cubic nucleus *fig. 20*, where it may be seen in what manner it would be necessary to proceed in order to extract this nucleus. For example, if a section be made passing through the points D, C, G, F, you will detach the pyramid resting on the face D C G F of the nucleus, which will by this section be uncovered.

Among the crystals belonging either to the sulphure of iron (martial pyrites), or the arseniate of cobalt (the arsenical cobalt ore of Tunaberg), there is found a dodecaedron, the faces of which are equal and similar pentagons, and its nucleus is a cube situated as above described. But there are an infinite number of possible dodecaedra, which may have, for faces, equal and similar pentagons, and will differ from each other by the respective inclinations of their faces. Of all these dodecaedra, the one, the structure of which would be subjected to the before-mentioned laws, gives $126^{\circ} 56' 8''$ as the angle made by the inclination of any two of its faces D P R F S, C P R G L (*fig. 19*), at the edge of junction P R, as may be easily demonstrated by calculation*. But though we cannot flatter ourselves with the hope of attaining to the precision of seconds, nor even to that of minutes, in measuring the same angle in dodecaedral pyrites, that measurement taken with every possible attention evidently approaches so near to the result given by calculation, that we may consider that result as the real boundary of approximation, found by help of the instrument, and conclude that

theory has arrived at the utmost point of accuracy. What I here say takes place also in regard to all the other results of theory compared with those of calculation; and it is obvious that if this theory were false, it would conduct to errors which the instrument would not fail to render sensible, by the great differences which it would give between the angles found by calculation and those found by measurement.

M. Verner and M. Romé de l'Isle have confounded the dodecaedron of pyrites with the regular dodecaedron of geometry, in which each pentagon has all its sides equal, and all its angles equal also*. If these two celebrated mineralogists had made more use of geometry in considering crystals, they would have perceived a very striking difference between these two dodecaedra, since the regular dodecaedron gives only $116^{\circ} 33' 54''$ as the inclination of its respective pentagons, which makes a difference of about $11^{\circ} \frac{1}{4}$ between it and that above mentioned. Nay, there is no law of decrement whatever capable of producing the regular dodecaedron, however compound it may be imagined, as I have shewn elsewhere † in regard to a cubic nucleus, and as I can demonstrate at present, generally, for a nucleus of any form. After these details it may be easily seen how important the use of calculation is, either to prove the truth of theory, or to trace out the boundaries by which the progress of crystallisation is circumscribed.

We have already then two kinds of dodecaedra; one, whose faces are rhombuses; and another, whose faces are pentagons; produced upon a cubical nucleus, in consequence of two simple and regular laws of decrement, in a direction parallel to the edges of the nucleus. A multitude of new polyhedra, which will have the same nucleus, may be constructed, by varying these laws in divers other ways.

* *Traité des Caract. des Fossiles*, page 184. See also, *La Crystallographie* de M. de l'Isle, t. iii. p. 232 and 233.

† *Mém. d. l'Acad. des Sciences*, année 1785, p. 223.

Calcareous Metastatic Spar (Fig. 21).*

Spath. calcaire à douze triangles. Daubenton. *Tabl. Miner.* édit. 1792, p. 15. n°. 5. De l'Isle, *Crystall.* t. i. p. 530, var. 1.

Geomet. Charact. Inclination of the triangle ofd to ofx , $104^{\circ} 28' 40''$, and to obd , $144^{\circ} 20' 26''$. Angles of the triangle ofd ; $f = 101^{\circ} 32' 13''$; $d = 54^{\circ} 27' 30''$; $o = 24^{\circ} 0' 17''$.

Geomet. Properties. The obtuse angle ofd of each triangle is equal to that of the rhombus of the primitive form.

The inclination of the faces ofd , ofx is equal to that of the rhombuses $bafd$, $gafx$ (fig. 4), of the nucleus†.

That part of the axis of the dodecaedron which exceeds on each side the axis of the nucleus, is equal to that axis; or, what amounts to the same thing, the whole axis of the dodecaedron is triple that of the nucleus.

The twelve scalene triangles that compose the surface of this variety have their lesser sides, which are united two to two on the six edges bd , df , fx , gx , gc , bc (fig. 21), exactly situated like those marked with the same letters in fig. 4, which gives an idea of the position of the nucleus in regard to the secondary crystal.

It is thence seen that the laminæ of superposition decrease in a direction parallel to the inferior edges bd , df , fx , &c. or the edges of which we have been speaking. The theoretic calculus demonstrates that this decreasing takes place in two ranges of integral molecularæ; and, as the laminæ always retain their rhomboidal figure, the sum of all their external angles, analogous to b , d , f , x , g , c , produces six longitudinal ridges, which form, alternately, the large and mean sides od , of (fig. 21), of the scalene triangles. It

* This variety is commonly called *dent de cochon*. The English call it dog's tooth, *dent de chien*.

† The word *metastatic* signifies transposition, or the *metastasis* of the angles of the nucleus to the secondary crystal.

may readily be conceived that the laminae, at the same time that they decrease towards their lower edges, ought, on the other hand, to increase towards their superior edges, analogous to ab , af , ag , &c. (*fig. 4.*) in such a manner that the parts of the crystal situated towards these edges should be always enveloped, and that the angles at the summits of the rhombuses should remain contiguous to the axis. But this is only an auxiliary variation, proper to second the effect of the decrease, which alone is sufficient to determine the form of the dodecaedron.

Very obtuse Calcareous Spar (Fig. 22):

Spath. calcaire rhomboïdal tr's obtus. Daubenton. *Tab. Miner.* edit. 1792, p. 15, n°. 2. De l'Isle, *Crystall.* t. i. p. 504. var. 2.

Geomet. Charact. Inclination of the rhombus $nad b'$ to the rhombus $aif d'$, $134^{\circ} 25' 36''$. Angles of the rhombus $nad b'$; a or $b' = 114^{\circ} 18' 56''$; n or $d' = 65^{\circ} 41' 4''$.

This variety, commonly called *lenticular calcareous spar*, arises from a decrement by a single range on both sides of the edges ab , ag , af (*fig. 23*), and ec , ed , ex , contiguous to the summits a , c , of the nucleus. An idea may be formed of its structure by comparing it with that of the dodecaedron whose planes form rhombuses (*fig. 5* and *12*) originating from the cube (*fig. 7*); and by supposing that the laminae, instead of decreasing at the same time on all the edges, decrease only towards those contiguous, three by three, to the angle C , and its opposite. In that case the faces formed will be reduced to six, which, by prolonging themselves according to the law of continuity, so as to intersect each other, will compose the surface of a rhomboid analogous to that in question; except that it will have other angles on account of the cubical form of its integral molecule.

From what I have here said it may be easily conceived that the diagonals drawn from a to b' (*fig. 22*), from a to g' , from a to f' , &c. on the secondary rhomboid, will be con-

founded with the edges $a b$, $a g$, $a f$, &c. (*fig. 23.*) of the nucleus, which serve as lines of departure for the decrements. Hence it follows, that to extract this nucleus it will be necessary to make the planes of the sections pass along the diagonals in question, as has been already remarked.

The Common Topaz (Fig. 25).

Rubis et Topaze du Brezil. Daubenton. *Tab. Miner.* edit. 1792, p. 7, n°. 1 and 2.

The inclination of the trapezoid $f r t m$ to the adjacent plane $r t e y$ 136° ; of the same plane to $k r y \approx 124^\circ 26'$; of the plane $t m g c$ to $m l i g$ 93° .

The primitive form of this topaz is that of a right quadrangular prism $b y$ (*fig. 24*), the bases of which are rhombuses, having the angle b or $r = 124^\circ 26'$. Theory shews that in regard to the integral molecule the height $r y$ is to the side $r n$ almost in the ratio of 3 to 2.

The pyramidal summit of the topaz results from a decrement by two ranges of small prisms on the edges $x r$, $r n$, $n b$, $b x$, of the superior base of the primitive form. The planes $t m g c$, $l m g c$ (*fig. 25*), on one side, and $b k z p$, $b u d p$ on the other, arise from a decrement by three ranges on each side of the edges $n v$, $x q$ (*fig. 24*), which decrement remains suspended at a certain term, and leaves four rectangles $t r y e$, $k r y x$, $l b c i$, $u b c d$ (*fig. 25*), parallel to the planes of the primitive form. The effect of this decrement is represented *fig. 26*, where the rhombus $b n r x$ is the same as *fig. 24*; and all the small rhombuses by which it is subdivided, or which are exterior to it, represent the bases of as many moleculeæ. The lines $x d$, $x z$, $n i$, $n c$, are directed according to the law of decrement already pointed out, and the lines $c d$, $c i$, $y z$, $y e$, answer to the planes of the prism, which are not subject to this law.

3. *Decrease on the Angles.*

The observation which gave birth to the present theory,
by

by pointing out the position of the rhomboidal nucleus inclosed in the regular hexaedral prism of the calcareous spar, was not sufficient to conduct immediately to a determination of the laws of those decrements which produce secondary crystals. It was necessary to pass through intermediate steps more simple than the result of these laws in regard to the prism in question. I shall now proceed to give an idea of these last results, which depend on laws of decrements whose lines of departure are not parallel to the edges of the primitive form, but to the diagonals of its faces.

To assist the imagination in conceiving the method which I have followed to investigate these new decrements, I shall remark, that the same substances which exhibit the dodecaëdron with pentagonal planes originating from the cube (*fig. 19 and 20*), and which might even assume the form of the dodecaëdron whose planes are rhombuses (*fig. 5 and 6*), are found also under that of the regular octaëdron. But it appears, on the first view, that it might be possible to bring the structure of this octaëdron to a decrement on the edges of a cube; for, if we confine ourselves to make the laminæ of superposition decrease only on the edges of the two opposite faces of this cube, for example, on those of the superior base *A B C D* (*fig. 6*), and of the inferior base, we shall have in general two pyramids applied on these bases; and if we suppose further that the faces of these pyramids are extended until they meet, which is nothing else than continuing the effect of the law of decrements in the space situated between the bases of the cube, we shall arrive at an octaëdron, the angles of which will vary according as the law shall determine a greater or smaller number of ranges subtracted. But theory demonstrates that there is no law, however complicated it may be supposed, which is capable of giving equilateral triangles as the faces of this octaëdron.

On the other hand, if we divide a regular octaëdron, originating from a cube, we shall perceive that the cubic nucleus is situated in this octaëdron in such a manner that each

of its six solid angles corresponds to the centre of one of the faces of the octaedron, which could not be the case on the hypothesis of a decrement on the edges. From this relation of position, added to the impossibility of applying here the theoretic calculus, I have concluded that the law of decrements accomplishes its end, in such cases, by a progress different from that which conducts to the forms before described; and my researches, in regard to that point, have unfolded a new order of facts which add much to the fecundity of crystallisation, and at the same time to that of its theory. But on this subject it is necessary to enter into a more particular investigation.

Let A B C D (*fig. 27*) be the superior or inferior surface of a lamina composed of small cubes, the bases of which are represented by the squares that sub-divide the whole square. If we consider the series of cubes to which the squares *a, b, c, d, e, f, g, h, i*, belong, it is evident that all these cubes will be on the diagonal drawn from A to C, and that they will form one string (*fig. 28*), which will not differ from the string of the cubes *a, n, q, r', s', t', u', z', x'*; (*fig. 27*) lying in the direction of the edge A D; except in this, that in the former the cubes touch only by one of their edges, and in the latter by one of their faces. We shall observe at the same time, throughout the whole extent of the lamina, strings of cubes parallel to the diagonal, one of which is pointed out by the series of letters *q, v, k, u, x, y, z*, another by that of the letters *n, t, l, m, p, o, r, s*, and so of the rest.

We may conceive then that the laminæ of superposition, instead of projecting beyond each other one or more ranges of cubes, in a direction parallel to the edge, project beyond each other in a direction parallel to the diagonal; and we shall construct in the like manner around the cubic nucleus solids of different figures, by placing, successively, above the different faces of this nucleus, laminæ, which may arise in the form of pyramids, and which will experience the kind of decrement just described. The faces of these solids will

not be simply furrowed by striæ, as when the laminæ decrease towards the ridges. They will be roughened by an infinite number of salient angles, formed by the exterior points of the composing cubes, which is a necessary consequence of the continually angular figure presented by the edges of the laminæ of superposition. But all these points being situated on a level, we may suppose the cubes so small that the faces of the solid will appear to form so many smooth and continued planes.

But this will be rendered more striking by an example. Let it be proposed to construct around the cube $ABGF$ (*fig. 29*), considered as nucleus, a secondary solid, in which the lamina of superposition shall decrease on all sides by a single range of cubes, but in a direction parallel to the diagonals. Let $ABCD$ (*fig. 30*), the superior base of the nucleus, be sub-divided into 81 small squares, representing the exterior faces of as many moleculeæ. What will be said in regard to that base may be applied to the other five faces of the cube.

Figure 31 represents the superior surface of the first lamina of superposition, which ought to be placed above $ABCD$ (*fig. 30*), in such a manner that the point a' may answer to the point a , the point b to the point b , the point c' to the point c , and the point d' to the point d . It may be readily seen by this disposition that the squares Aa , Bb , Cc , Dd , (*fig. 30*), remain uncovered, which will fulfil the law of decrement above described. It is moreover seen that the borders QV , ON , IL , GF , (*fig. 31*), project by one range beyond the borders AB , AD , CD , BC , (*fig. 29*), which is necessary, that the nucleus may be enveloped towards these edges. For a little attention will shew, that if this were not the case, that is to say, if the edges of the lamina represented *fig. 31* as well as the following, coincided with the lines ST , EZ , YX , MU , on which supposition they would be on a level with AD , AB , CD , BC , (*fig. 30*), they would form re-entering angles towards the analogous parts

of.

of the crystal. Thus in the laminæ applied on $ABCD$ (*fig. 29*), all the edges answering to CD would be on a level with $CDFG$, of which they would form a prolongation; and in the laminæ applied on $DCGF$ all the edges analogous to the same ridge CD would be on a level with $ABCD$, from which there would necessarily result a re-entering angle opposite to the salient angle formed by the two faces $ABCD$ and $CDFG$. But the re-entering angles appear to be excluded by the laws which determine the formation of simple crystals. The solid will increase then in those parts to which the decrement does not extend. But as this decrement is alone sufficient to determine the form of the secondary crystal, we may set aside all the other variations which intervene only in a subsidiary manner, except when it is wished, as in the present case, to construct, artificially, a solid representation of a crystal, and to exhibit all the details which relate to its structure.

The superior face of the second lamina will be like A', G', L', K' , (*fig. 32*), and this lamina must be placed above the preceding in such a manner that the points a'', b'', c'', d'' , may answer to the points a', b', c', d' , (*fig. 31*), which will leave uncovered the squares that have their exterior angles situated in Q, S, E, O, V, T, M, G , &c. and continue to effect the decrement by one range. It is here seen that the solid increases successively towards the analogous edges at AB, BC, CD, AD (*fig. 30*), since between A' and L' , for example, (*fig. 32*), there are thirteen squares, whereas there are only eleven between QV and LI (*fig. 31*). But as the effect of the decrement contracts more and more the surface of the laminæ in the direction of the diagonals, nothing is necessary but to add towards the edges that do not decrease, a single cube denoted by A', G', L' or K' , (*fig. 32*), instead of the five which terminate the preceding lamina along the lines QV, GF, LI, ON , (*fig. 31*).

The large faces of the laminæ of superposition, which hitherto were octagons, $QVGFI LNO$, (*fig. 31*), having

arrived at the figure of the square $A' G' L' K'$ (*fig. 32*)*, will, when they pass that term, decrease on all sides at the same time, so that the following lamina will have for its superior face the square $B' M' I' S'$ (*fig. 33*), less by one range in every direction than the square $A' G' L' K'$ (*fig. 32*): This square must be disposed above the preceding in such a manner that the points c', f', g', b' , (*fig. 33*), may correspond with the points c, f, g, b (*fig. 32*).

Figures 34, 35, 36 and 37 represent the four laminæ which ought to rise successively above the preceding, under this condition, that the same letters must correspond as above. The last lamina will be reduced to a single cube, distinguished by α' (*fig. 38*), and which ought to rest upon that pointed out by the same letter *fig. 37*.

It follows from what has been said, that the laminæ of superposition applied on the base $A B C D$ (*fig. 29 and 30*) produce by the total of their decreasing edges four faces, which, in proceeding from the points A, B, C, D , incline one to another in the form of a pyramidal summit.

It is here to be remarked, that the edges in question have lengths which begin by increasing, as may be seen on inspecting *fig. 31 and 32*, and which then proceed decreasing, as may be seen by the following figures. It thence results that the faces produced by the same edges increase at first, and afterwards decrease in breadth, so that they become quadrilaterals. Figure 39 represents one of these quadrilaterals, in which the inferior angle C is confounded with the angle C (*fig. 29*) of the nucleus; and the diagonal $L Q$ represents the edge $L' G'$ of the lamina $A' G' L' K'$ (*fig. 32*), which is the most extended in the direction of that edge. And as the number of the laminæ of superposition which produce the triangle LCQ (*fig. 39*) is less than that of the laminæ which produce the triangle LZQ , since there is here only one

* In the present case this figure takes place from the second lamina of superposition. By assuming a nucleus composed of a greater number of moleculeæ, it is evident that we should have a more remote boundary.

lamina preceding the lamina $A'G'LK'$ (*fig. 32*), while there are six which follow it as far as the cube z (*fig. 38*) inclusively, the triangle LZQ (*fig. 39*), composed of the sum of the edges of these latter laminæ, will have a much greater height than the inferior triangle LCQ , as expressed in the figure.

The surface of the secondary solid will be formed then of 24 quadrilaterals, disposed three and three around each solid angle of the nucleus. But in consequence of the decrement by one range, the three quadrilaterals which belong to each solid angle, such as C (*fig. 29*), will be in the same plane, and will form an equilateral triangle ZIN (*fig. 40*). The twenty-four quadrilaterals then will produce eight equilateral triangles, one of which is represented *fig. 41*, in such a manner as to shew, on a simple view, the assortment of the cubes that concur to form it; and the secondary solid will be a regular octaedron. Figure 42 shews this octaedron in which the cubic nucleus is inclosed, so that each of its solid angles C, D, F, G , &c. corresponds to the centre of one of the triangles IZN, IPN, PIS, SIZ , &c. of the octaedron. It may be readily seen, that to extract this nucleus, it would be necessary to divide the octaedron in its eight solid angles, by sections parallel to the opposite edges. For example, the section made in the angle Z ought to be parallel to the edges IS, IN, TN, TS ; and hence will result a square which will itself be situated parallel to the superior base $ABCD$ of the nucleus, and which will be confounded with that base when the sections have made the faces of the octaedron to disappear entirely.

This structure is that of the octaedral sulphure of lead (galena), and the muriate of soda (common salt) of the same form.

I call decrements on the angles, those which take place in a direction parallel to the diagonals, as in the example just mentioned. This denomination will supply us with the means of expressing in a precise manner the result of each

decrement, by pointing out the angle which serves it as a point of departure.

Other Examples of Decrements on the Angles.

Acute calcareous Spar (*fig. 43*).

Spath calcaire rhomboïdal aigu. Daubenton, *Tab. Miner.*, edit. 1792, p. 15. n. 3. *Spath calcaire muriatique.* De l'Isle *Cbrystallographie*, t. i. p. 520. var. 12.

Geomet. Charact. Inclination of $p \approx r y$ to pu oy $78^{\circ} 27' 47''$ and to $ir \approx s$ $101^{\circ} 32' 13''$. Angles of the rhombus $p \approx r y$, $p \approx r r = 75^{\circ} 31' 20''$; \approx or $y = 104^{\circ} 28' 40''$. Inclination of the oblique diagonal drawn from p to r with the edge pu , $71^{\circ} 33' 54''$.

Geomet. Propert. The angles of the rhombus are equal to the respective inclinations of the faces of the nucleus, and reciprocally.

The angles of the principal quadrilateral, or that which passes through two opposite oblique diagonals pr , ui , and through the intermediate edges pu , ir , are the same as on the nucleus.

To conceive the structure of this rhomboid, let us suppose that $abdf$ (*fig. 44*) represents the face of the nucleus marked by the same letters (*fig. 4*), subdivided into a multitude of partial rhombuses, which are the exterior faces of so many moleculeæ. Let us suppose farther, that the laminæ of superposition, applied on this face, decrease by one range towards the lateral angles abd , afd in such a manner that, on the first the two rhombuses $b h k l$, $f m i n$ are uncovered, that on the second the uncovered rhombuses are those traversed by the diagonals co , uy , on the third those traversed by the diagonals st , qz , &c. in which case the decreasing edges will successively correspond with these diagonals. This law of decrement will produce two faces, which proceeding from the angles b , f will rise in the form of a roof above the rhombus $abdf$, and will meet on a common edge situated immediately above the diagonal ad , and which will

be parallel to it; and as there are six rhombuses that undergo like decrements on the primitive form, the faces produced will be twelve in number. But in virtue of the law of decrease by one range, the two faces which have the same angle, b, f, g , &c. (*fig. 4*), for the point of departure, will be in the same plane, which reduces the twelve faces to six, and transforms the secondary crystal into an acute rhomboid pi (*fig. 43*).

This rhomboid, from what has been said, has its edges, pz, py, pu , situated each as the oblique diagonals of the nucleus, or those which would be drawn from a to d , from a to x , from a to c , &c. (*fig. 4*).

The edges of the laminæ of superposition experience, in the parts to which the decrement does not extend, auxiliary variations, in virtue of which they are prolonged to envelop the nucleus towards these parts, as in the regular octaedron, the structure of which has been already explained. Moreover, while the laminæ decrease, for example on the angles afd , afx , (*fig. 4*), they undergo also towards the adjacent angle dfx , variations which intervene in a subsidiary manner to aid the effect of the principal decrement. The variations here are also decrements by a simple range on the inferior angles. But in case the principal decrement should proceed by two ranges, three ranges, or a much greater number, these variations would become decrements of a particular nature, and which would not be parallel to the diagonals.

In short, we might apply here what we have already said in regard to the first variations considered on the regular octaedron, and observe, that the principal decrement alone determines the form of the secondary crystal; so that this decrement being well comprehended, nothing is then necessary but to suppose its effect prolonged, in order that the faces to which it gives birth may intersect each other in such a manner as to circumscribe entirely the space to which they correspond.

M. Bournon has discovered beautiful crystals of this

variety at Coufon near Lyons. It is observed also in small yellowish crystals, often thrown together in confused groups in the calcareous banks near Paris. The freestone (lapis arenarius) of Fontainbleau, which is nothing else than calcareous spar accidentally mixed with quartz particles, exhibits the same form. The crystals of this stone yield to the mechanical division; and have their natural joinings, like those of the crystals of pure spar, situated in the planes parallel to the edges $p\alpha$, py , pu , &c. (fig. 43), and which would pass at an equal distance from these edges.

Rhomboidal Iron Ore (fig. 45).

Mine de fer lenticulaire. Daubenton, *Tab. Miner.* edit. 1792. p. 30, n°. 3.

Geomet. Charact. Inclination of BCRP to BCOA or O CRS, $146^{\circ} 26' 33''$; Angles of the rhombus BCRP, C or P = $117^{\circ} 2' 9''$; B or R = $62^{\circ} 57' 51''$.

The laminæ which compose this rhomboid decrease by two ranges on the angles bcr , ocr , bco , &c. (fig. 46), which concur to the formation of the two solid angles c , n , of a cubic nucleus. The faces produced, instead of being on a level, three and three, around these angles, as in the case of a decrement by a single range, incline one to the other, and extend above the faces of the nucleus in such a manner that their diagonals are parallel to the horizontal diagonals of the same faces.

By this it is seen that the cube here answers the purpose of a rhomboid, which should have its summits in c and n , in which case there would be only one axis passing through the summits in question. In the dodecaedron, on the other hand, with pentagonal planes (fig. 19), the cube performs the functions of a rectangular parallelopipedon, and then we may conceive three different axes, each of which passes through the middle of the two opposite faces. I have observed that when the cube began to perform the one or
other

other function, in regard to one species of mineral, it continued that function in all the varieties of that species.

The crystals of rhomboidal iron are found among those of the iron ore of the island of Elba. But it is very uncommon for the law of decrement to attain to its boundary, and for the rhomboid not to be modified by facets parallel to the faces of the nucleus.

If the decrement which produces the rhomboid took place at the same time on the eight solid angles of the cube, there would result from it a polyedron of 24 facets, all like the trapezoidal granite, of which I shall speak hereafter, but with a very different structure. This result is realised by nature in the crystals found at the Calton-hill near Edinburgh, which are considered as zeolites.

[*To be continued.*]

X. *Method to destroy or drive away Earth-worms and various other Insects hurtful to Fields and Gardens, by M. SOCOLOFF. From the New Transactions of the Imperial Academy of Sciences at Petersburg, Vol. V.*

THOUGH it is certain that earth-worms occasion great destruction by gnawing the tender roots of shrubs and plants, and that other insects, such as caterpillars and locusts, are exceedingly hurtful both to fields and gardens, few have given themselves the trouble to devise any remedy for this evil. I flatter myself, therefore, that I shall do a service to the public if I point out an easy and sure method, certified by experience, of either killing or driving away from fields and gardens all noxious vermin.

As the destructive power of quick-lime, heightened by a fixed alkali, which corrodes, dissolves and destroys all the tender parts of animals, has been long known, I thought this mixture would be the best means for accomplishing the object I had in view. I took three parts, therefore, of quick-lime

lime, newly made, and two parts of a saturated solution of fixed alkali in water, and thence obtained a somewhat milky liquor sufficiently caustic, highly hostile and poisonous to earth-worms and other small animals; for, as soon as it touched any part of their bodies, it occasioned in them violent symptoms of great uneasiness. If this liquor be poured into those holes in which the earth-worms reside under ground, they immediately throw themselves out as if driven by some force; and, after various contortions, either languish or die. If the leaves of plants or fruit-trees, frequented by the voracious caterpillars, which are so destructive to them, be sprinkled over with this liquor, these insects suddenly contract their bodies and drop to the ground. For though nature has defended them tolerably well by their hairy skins from any thing that might injure their delicate bodies, yet, as soon as they touch with their feet or mouths leaves which have been moistened by this liquor, they become as it were stupefied, instantly contract themselves, and fall down.

I had not an opportunity of trying a like experiment on locusts: yet we may conclude, and not without probability, from their nature, and the general destructive qualities of the above liquor, that they, in the like manner, may be driven from corn-fields, if it be possible to sprinkle the corn with the liquor by means of a machine.

With regard to plants or corn, these sustain no injury from the liquor, because it has no power over the productions of the vegetable kingdom, as I have fully learned from experience; or, if any hurt is to be suspected, all the danger will be removed by the first shower that falls. This liquor may be procured in abundance in every place where lime is burnt. If the lime be fresh, one part of it infused in about seventy parts of common water will produce real lime-water. The want of the fixed alkali may be supplied by boiling wood-ashes in water, and thickening the lye by evaporation.

This liquor might be employed also to kill bugs and other
domestic

domestic insects which are noxious and troublesome; but, on account of its strong lixivious smell, which disposes the human body to putridity, I dare not recommend the use of it in houses that are inhabited. Besides, bugs may be easily got rid of, as I have repeatedly found from experience, by the oily pickle that remains in casks in which salted herrings have been packed. To this liquor they have a strong aversion; and, if they are moistened with it, they die in a very short time.

XI. *On the Revivification of some Kinds of Insects killed in Spirit of Wine.* By M. SOCOLOFF. *From the New Transactions of the Imperial Academy of Sciences at Peterburgh, Vol. V.*

IT is very singular, and worthy of great attention, that a small insect intoxicated with spirit of wine and then immersed in it, or killed on purpose in that manner, may, by certain means, be revived, after having been deprived of all signs of life for about a quarter of an hour. I had occasion to observe this circumstance, for the first time, in common flies; for it is well known that these insects are strongly attracted by the smell of spirit of wine; and that, becoming intoxicated by it, they fall into the liquor, and are drowned. Having thrown a great number of flies which had perished in this manner in a glass, into a stove among wood ashes scarcely warm, and looking into the stove a little while after, on account of some experiments I was making, I observed, not without astonishment, the flies start up from the ashes, and, after wiping themselves clean from the dust adhering to their wings, fly away as if nothing had happened to them*.

My

* A circumstance of a similar kind occurred to the late Dr. Franklin. While he resided in France he received from America a quantity of Ma-
deira

My curiosity being excited by this circumstance, I left a wide-mouthed glass, into which I had put some spirit of wine, uncovered, on purpose, and, having collected the flies which I afterwards found dead in it, I buried them carefully among the before-mentioned wood-ashes; and in a little time, when the moisture of the spirit had been completely absorbed by the ashes, I observed them all revived. Being convinced in this manner that the experiment would succeed with common flies, I resolved to make a like trial with other kinds of insects. I therefore took some small beetles, which were those nearest at hand, put them into a glass filled with spirit of wine, and, when they were perfectly dead, covered them with ashes. These, to my great satisfaction, were restored to life in the like manner.

I made an experiment also with a small spider and a young moth, by depriving them of life five different times within the course of three hours, and always with the wished-for success, except that the spider, after the last experiment, was become so languid and weak that it could scarcely crawl. I found the like effect to be produced on bugs, only that it was necessary to keep them longer in the ashes before they were brought to life.

In regard to butterflies I cannot speak with certainty, as those on which I made experiments were feeble and sickly. Common wood-lice on the other hand, after being killed in spirit of wine, I could not bring to life by the same means. Further experiments on this subject I shall leave to naturalists and physicians, who, perhaps, may infer from the above observations, that warm wood-ashes might be employed, not

deira wine which had been bottled in Virginia. In some of the bottles he found a few dead flies, which he exposed to the warm sun, it being then the month of July, and in less than three hours these apparently dead animals recovered life which had been so long suspended. At first they appeared as if convulsed; they then raised themselves on their legs, washed their eyes with their fore feet, dressed their wings with those behind, and began in a little time to fly about. EDIT.

without advantage, by way of fomentation, to gouty and paralytic limbs, and for those afflicted with rheumatic complaints.

XII. *Chemical Experiments respecting different Methods of rendering Paper and the Writing on it indestructible by Fire.* By Mr. L. BRUGNATELLI. From Crell's Chemical Annals for 1797.

Various Methods of rendering Writing indestructible.

[Concluded from Page 92.]

WHEN I had discovered the means by liquor of flint to render paper so much less combustible, and also in particular to prevent its being converted into ashes, I resolved to examine how common ink would stand on paper prepared in that manner. I imagined that ink, on account of the oxydated metal contained in its mixture, would not be so easily destroyed by the fire; for, though it is not naturally black when freed from the acid of galls, it must however be somewhat visible as soon as the substance on which it is put is rendered indestructible. And this I actually found to be the case, after writing a few lines with good common ink upon a leaf of paper which had been carefully prepared with liquor of flint, and putting it into the fire till it was burnt to a coal. I examined the writing with attention, and found that several words which I had written upon it could be read, though the paper was reduced to a coal. All the words could not indeed be distinguished with the same clearness, and therefore they could not be all properly read. Some of them had a red ochrey colour, and these were the clearest; others were blackish, and some were of so dark a tint that they were almost entirely blended with the colour of the charred paper: the last were totally illegible. These phenomena are perfectly agreeable to the nature of oxydated iron;

iron, which, as is well known, assumes the above-mentioned tints, according as it contains more or less oxygene or carbon.

On account of the oxydated iron, as I could not employ common ink for my proposed object, I sought among the oxydated metals for one that was capable of striking the eye on a black ground, and which at the same time would combine with common ink*.

To common ink I added a portion of oxydated bismuth, which, according to its own nature, is exceedingly white, and which on a black ground would produce visible characters that must then be legible. I prepared the mixture, and obtained a somewhat thick ink, which did not flow readily, and with which I could write a few lines, but not without difficulty. Paper written upon with this ink I burnt in a wood fire, and examined it as soon as it was reduced to coal. I however found that the words were not more legible than those written with common ink; for the oxydated bismuth communicated its oxygene to the inflammable parts of the mixture, and the whole was revived into a metallic regulus: several small grains of regulus of bismuth could therefore be distinguished in it with the naked eye. I mixed common ink with several other oxydated metals, and with several kinds of earths; but the ink by these was so much changed in its colour and consistence, that I thought it unnecessary to pay any farther attention to it. I had recourse, therefore, to dissolved metals, because ink by these is not changed in its consistence, as by oxydated metals, and particularly earthy bodies.

But before I made any mixture with common ink, I wished to try what colour characters made with dissolved metals only would assume, on paper prepared as before, when reduced to coal.

I wrote, therefore, on different leaves of paper, which had been soaked in liquor of flint, with a common solution of

* For common ink any other black dye may be substituted.

gold; nitrite of silver, copper, tin, lead, bismuth, cobalt, antimony, and manganese. None of the characters written with the above solutions could be read by the naked eye, except that written with nitrite of copper, which appeared of a beautiful green colour. I burnt all these leaves in a flame, and the results were as follows:

The characters made with solutions of gold and silver were not visible on the charred paper, on account of the dark tint which they assumed in the fire. The case was the same with those characters made by solutions of cobalt, antimony, and lead.

I have found that dissolved nitrite of cobalt may be employed with great advantage for making sympathetic ink, not inferior to the celebrated ink prepared from the same metal dissolved in the nitro-muriatic acid, or aqua-regia; which, as is well known, becomes visible of a beautiful green colour by heat, and disappears in the cold. Characters written with dissolved nitrite of cobalt became visible, of a beautiful violet colour, on paper prepared as above. I held the leaf of paper, on which I had written with the before-mentioned solution, a few seconds over the fire; and when I took back the leaf I could read the characters, before invisible, as they now appeared of a violet colour; but the colour gradually disappeared, and the writing again became invisible. When I held the paper so near the fire that it was a little singed, the characters appeared white, and disappeared again in the cold.

Characters made with nitrite of antimony were not visible, because they were as black as the charred paper. But when the paper was held to the light they could be read a little, because the oxydated metal made the characters exceedingly opaque, and therefore easily to be distinguished from the rest of the paper, which was more or less transparent.

Characters made with dissolved nitrite of tin gave the same result as the preceding. Those also made with a solution of bismuth were scarcely visible after being in the fire; and when the fire was brisk it destroyed the charred paper, while

while the oxydated bismuth was converted into metal*. The invisible letters made with a solution of this metal can be read also, if the paper be dipped into pure water. By this simple process the characters appear of a white colour, as the paper becomes somewhat darker. The writing, however, may be read better if the paper be then held to the light, because the paper, which becomes somewhat transparent, suffers the characters, which are altogether dark, to be seen.

I thought it unnecessary to make any experiments with dissolved arsenic and quicksilver, because their oxydes easily suffer the oxygene to escape; sublime in the fire, and then entirely fly off from the burning body.

Of all the metallic salts, I found only nitrite of copper and zinc fit for my proposed object; for the calces of these metals continue fixed in the fire, and shew themselves afterwards in durable and bright colours.

The characters which I wrote with dissolved nitrite of copper were exceedingly visible, of a copper colour on the charred paper, and this colour can be well distinguished on a dark ground. When I wrote with dissolved ammoniacal copper, instead of nitrite of copper, the characters assumed in the fire a dark red colour, which approached that of cinabar. Dissolved nitrite of zinc, however, is the best of all the substances with which I made experiments, because characters written with it on paper prepared by liquor of flint were legible; and it is therefore preferable to solutions of copper, or of any other substance.

When I wrote with dissolved nitrite of zinc, the characters were not visible; but when the paper was burnt they were

* To observe this phenomenon better, it will be sufficient to write on a leaf of paper which has been impregnated with sal-ammoniac, and then to burn it over the flame of a candle. The charred paper remains smooth: but at the places where the characters were written a beautiful small border of regulus of bismuth is seen, so that when the paper is held to the light many of the words written upon it may be read.

so visible, in a clear white colour on a dark ground, that they could be read with as much ease as characters written with the best ink on white paper.

I shall now examine whether dissolved nitrite of zinc, which produces so beautiful a sympathetic ink, can be combined with common ink, without the latter being so changed in its colour as to be rendered unfit for use as before. I made this mixture, and found that the ink became somewhat pale by the nitrite of zinc, on account perhaps of the nitrous acid, which probably lessened the combination of the acid of galls with the iron: but I could write with it very well on paper prepared by my liquor of flint; for the colour of common ink mixed with nitrite of zinc, which appeared on common paper to be somewhat weakened, became so dark on prepared paper, that words written with it appeared more conspicuous than those written with common ink. The white colour of which the characters appeared, on the charred paper, was not changed by the mixture of ink, as I was fully convinced by repeated experiments.

One part of my curiosity was still not gratified, as I wished to know of what colour the dissolved metals would appear on paper impregnated with different salts. For that purpose I made the following experiments:

I wrote on paper, which had been impregnated with acetite of barytes, with a solution of gold, nitrite of silver, copper, bismuth, tin, lead, antimony and zinc. The characters written with a solution of gold appeared on the charred paper of a beautiful poppy red, and those with a solution of copper of a dark yellow. Those written with a solution of antimony, zinc, bismuth, tin and lead, could not be seen.

I wrote also with solutions of the above metals on paper which had been soaked in muriate of lime. The characters written with solutions of gold and silver appeared on the paper like those written on paper soaked in acetite of barytes. Those written with solutions of lead and bismuth appeared white; and those written with a solution of copper appeared

red. Those written with solutions of tin, antimony and zinc, were not legible. Paper impregnated with sulphite of potash was totally destroyed in the flame, as above remarked. I thought it necessary therefore to make experiments with other sulphites; because I had before observed that such salts, by means of inflammable bodies, are converted into sulphureous bodies.

I wrote also with the common dissolved metals, on paper which had been impregnated with muriate of soda. The characters written with a solution of gold could scarcely be distinguished of a dark red colour; but those written with all the other dissolved metals were not legible.

I wrote with the same solutions on paper which had been soaked in a solution of muriate of ammoniac, but none of the characters were visible on the paper when reduced to coal.

I wrote, in the last place, with the same substances on paper which had been soaked in a solution of nitrite of lime, and, when reduced to coal, I could read the characters written with a solution of gold of a beautiful rose red; and those written with a solution of silver of a yellow colour; but the charred paper was white. The other characters were not legible, except those written with nitrite of bismuth, which had assumed a blackish colour.

The other pieces of paper soaked in solutions of different salts gave no result worthy of notice.

The above observed effects and before-mentioned chemical preparations were the means of leading me to several pleasant experiments. I wished, for example, to bring it about that the burnt paper should be converted into a white indestructible coal, on which the characters might be legible of different colours, and accomplished my object in the following manner:—I rubbed some gum arabic mixed with pure magnesia by means of a hair brush, over the paper soaked in liquor of flint. When the paper was dry, I wrote on it several lines, some with a solution of gold, and others with a solution of antimony in aqua-regia. The characters made
with

with both these solutions were totally illegible. I then threw the prepared paper thus written upon into the fire; and when it was wholly reduced to a coal, all the lines could be read of a black colour on a white ground, so that the characters were almost like those written with common ink on white paper. If it be required to make the solutions of gold and antimony black, that the words written with them may be more distinguishable before the paper is burnt, it will only be necessary to add a little common ink to them, but such as contains as small a quantity as possible of the sulphite of iron*.

I dipped paper which had been prepared with liquor of flint in a saturated solution of nitrite of zinc, and suffered it to become exceedingly dry in the sun. I then wrote on several bits of this paper with the solutions of different metals, and a few hours after reduced them all to coal, by holding them one after the other in the fire. Characters written with dissolved nitrite of copper appeared of the colour of metallised copper; those written with dissolved nitrite of iron, or bismuth, of a yellow colour; those with

* In the same manner as charred paper is made to assume a white colour when it has been before washed over with a mixture of gum arabic and magnesia, it may be made to assume any other colour if the paper be dipped sometimes in one and sometimes in another of the above-mentioned solutions, as the characters on the charred paper will then assume sometimes one colour and sometimes another. If paper, for example, which has been soaked in liquor of flint, be held a little in a solution of sulphite of copper, and then dried, the paper will assume a beautiful green colour. If the paper be burnt, it assumes a copper colour. If you write on paper, already tinged green, with any metallic solutions of metals which are not so easily decomposed by the action of the fire, singular phenomena will be observed. If you write on it with sulphite of iron, the characters will be read of a yellowish colour. When the paper is reduced to coal, the characters are still seen yellow. If you write with dissolved nitrite of antimony, the characters appear whitish. If the characters are written on such paper with nitrite of zinc, they are invisible; but when the paper is reduced to coal, they appear of a silver colour, &c.

dissolved nitrite of antimony, black; and those with a solution of gold, of a gold colour. Those made with the last solution appeared several times of the colour of black velvet. When you write on the above-mentioned paper with iron dissolved in diluted nitrous acid, the characters will appear of an orange yellow colour, if the paper be often heated without reducing it to coal.

P. S. I am now employed in endeavouring to discover a method of rendering paper prepared with liquor of flint stronger, so that when burnt it may not be so friable, in order that when several sheets of paper are burnt upon each other they may be easily separated, and the whole writing on them be read. As soon as I have derived any results from my experiments, I shall not fail to communicate them.

XIII. *On Test Liquors for detecting Acids and Alkalis in Chemical Mixtures. Extracted from Mr. WATT's Paper on that Subject in the Philosophical Transactions for 1798, Part I.*

MR. WATT of Birmingham, to whom the philosophical world is so much indebted for various discoveries and improvements, has turned his attention to this subject, and has favoured the world with the result of his investigation. He observes, that the great degree of sensibility of an infusion of litmus (syrup of violets having been for some time out of use as a test, as it has been found not to be sufficiently accurate), the blue colour of which is changed into red by the presence of a very minute quantity of any acid, would leave very little necessity to search for any other, were there reason to believe that it is always a test of the exact point of saturation of acids and alkalis, which the following fact seems to call in question:—"A mixture of phlogisticated nitrous acid with an alkali will appear to be acid by the test of litmus, when other tests, such as the infusion of the petals of the scarlet rose, of the blue iris, of violets, and of other

other flowers, will shew the same liquor to be alkaline by turning green."

Paper stained with infusions, or with the juices of the petals of such flowers as have been just mentioned, though an excellent test for alkalis, is not so easily affected by acids as litmus, and, by keeping, loses in a short time much of its sensibility.

To obtain fresh made tests from vegetables, few of which are to be met with in winter, was a matter of considerable moment. Mr. Watt found the red cabbage (*brassica rubra*) to furnish the best. In its fresh state it is more sensible both to acids and alkalis than even litmus, and more decisive from its being naturally blue; turning green with alkalis, and red with acids.

Mr. Watt extracts the colouring matter from the thin parts of the leaves only. He minces them small, and digests them in water about the heat of 120° for a few hours. If not to be immediately used, as it is apt to spoil, Mr. Watt recommends to spread the minced leaves on paper, to dry them in a gentle heat, and then to put them in bottles well corked. To prepare the test, infuse or digest these dried leaves in water acidulated with sulphuric acid till they give out their colour; then strain the liquor through a cloth, and add to it whiting or chalk, stirring it frequently, until it becomes a true blue, neither inclining to green nor to purple. When this point is gained, filter it immediately; otherwise it will become greenish by standing on the chalk. It will deposit some gypsum, and, by adding a little spirit of wine, will keep good for some days. Too much spirit destroys the colour. If wanted to be kept longer, neutralise it by means of a fixed alkali instead of chalk. But as none of these means will preserve the liquor long without requiring to be neutralised afresh just before it is used; and as the fermentation which it undergoes, and perhaps the alkalis or spirit of wine mixed with it, seem to lessen its sensibility; in order to preserve its virtues, while it is kept in a liquid state,

some fresh leaves, minced as has been directed, may be infused in a mixture of vitriolic acid and water, of about the degree of acidity of vinegar; and it may be neutralised as it is wanted, by chalk, or fixed or volatile alkali. Avoid an excess of alkali, as it will turn the colour yellow.

By the same process Mr. Watt made a red infusion of violets, which on being neutralised formed a very sensible test; but how long it might be preserved, he had not determined.

Mr. Watt recommends to use the tests in a liquid state; as he observes, and with justice, that the size and alum in writing-paper in some degree fix the colour, while paper not sized becomes too transparent, when wetted, to render small changes of colour perceptible.

To the above useful hints of Mr. Watt we shall add another.—The skins of red radishes yield by being bruised a very sensible test, and, no doubt, might be preserved by the means he has pointed out.

XIV. *An Account of the Sugar Maple of the United States*, by BENJAMIN RUSH, M. D. Professor of the Institutes of Medicine in the University of Pennsylvania, communicated by ROBERT JOHN THORNTON, M. D. Lecturer on Medical Botany at Guy's Hospital.

THE *acer saccharinum* of Linnæus, or sugar maple tree, is found in great abundance in the western counties of all the middle states of the American Union. Those which grow in New York and Pennsylvania yield the sugar in a greater quantity than those which grow on the water of the Ohio. They are when at maturity, that is, when about twenty years old, as tall as an oak, and from two to three feet in diameter. They put forth a beautiful white blossom in the spring before they shew a single leaf. The colour of the blossom distinguishes the sugar maple from the *acer rubrum*, or common maple, which has a red flower. Its small branches

branches were cut by the first settlers for the support of cattle during the winter, who thrive greatly upon them. The wood is extremely inflammable, and therefore makes fine fire-wood. Its ashes afford a great quantity of pot-ash, exceeded by few, or perhaps by none, of the trees that grow in the woods of the United States.

The acer saccharinum is not injured by tapping; on the contrary, the oftener it is tapped, the more syrup is obtained from it. The effects of a yearly discharge of sap from the tree in improving and increasing the sap, is demonstrated from the superior excellence of those trees which have been perforated in an hundred places by a small wood-pecker which feeds upon the sap. The sap of such trees is much sweeter to the taste than that obtained from trees which have not been previously wounded, and more sugar is afterwards procured. In this last particular it follows a law of the animal economy. It is well known, that when a person has been once tapped, the process requires afterwards to be more frequently repeated. A single tree has not only survived, but flourished after forty-two tapplings in the same number of years.

A tree of an ordinary size yields, in a good season, from twenty to thirty gallons of sap, from which are made from five to six pounds of sugar. To this there are sometimes remarkable exceptions. Samuel Low, Esq. a justice of peace in Montgomery county, in the State of New York, informed Arthur Noble, Esq. that he had made twenty pounds and one ounce of sugar from the 14th to the 23d of April, in the year 1789, from a single tree that had been tapped for several successive years before. The quantity obtained per diem varies from five gallons to a pint, according to the variations of the weather. The influence which this has in increasing or lessening the discharge of the sap is very remarkable. I have seen a journal of the effects of heat, cold, moisture, drought, and thunder, upon the discharges from the sugar tree; which disposes me to believe there is some foundation

in Dr. Tongue's opinion, who supposes that changes in the weather of every kind might be as readily ascertained by discharges of sap from trees, as by the barometer. (Vide Philosophical Transactions, N^o 68.) Warm days succeeding frosty nights are most favourable to a plentiful discharge of sap. If frosty nights succeed a warm day, there is always a total suspension of the discharge*.

The

* Dr. Hale, in his Vegetable Statics, relates that he cut down a vine, and cemented to its mutilated stump glass tubes, each 7 feet long, and one fourth of an inch diameter, with brass caps, by which they were screwed on one above another, till they rose to the height of 36 feet.

By these gages it appeared,

1st. That the sap began to rise March 10, when the thermometer by day stood only at 3 degrees above the freezing point.

2dly. That, April 18, it was at its height and vigour.

3dly. That from that time to May 5, the force gradually decreased.

4thly. That it constantly rose fastest from sun-rise to about 9 or 10 in the morning, and then gradually subsided till about 5 or 6 o'clock in the afternoon.

5thly. That it rose sooner in the morning after cool weather, than after hot days, and in proportion to the coldness of the night and subsequent heat.

6thly. That after several successive cold days and nights, the sap would rise during the whole day, if it chanced to be fine, although slowest at noon.

7thly. That if warm weather had made the sap flow vigorously, that vigour would be abated immediately by a cold easterly wind and a cloudy sun, when the sap would sink at the rate of an inch per minute; but when the sun shone out, and the wind shifted, it rose again as usual.

8thly. The oldest vines were soonest affected by a change of temperature, and in them the sap first began to sink.

9thly. And, on the contrary, when the tube was fixed to a very short stump of a young vine, and at only 7 inches from the ground, the sap flowed incessantly, and fastest of all, in the greatest heat of the day, sinking only after sun-set.

He then makes this general conclusion, that the rapidity with which the sap circulates in the vine during the spring, is five times greater than the rapidity with which the blood flows in the arteries of a horse; that it is considerably slower in the summer than in spring, very languid in autumn, and ceases altogether in the winter.

The

The sap usually flows for six weeks, varying according to the temperature of the weather. The season for tapping is in February, March, and April. During the remaining part of the spring months, as also in the summer, and in the beginning of autumn, the maple tree yields a thin sap, but not fit for the manufactory of sugar.

Baron La Hontan gives the following account of the sap of the sugar maple tree, when used as drink, and the manner of obtaining it. The tree, says he, yields a sap which has a much pleasanter taste than the best lemonade or cherry water, and is the wholesomest drink in the world. This liquor is drawn by cutting the tree two inches deep in the wood, the cut being made sloping to the length of ten or twelve inches; at the lower end of this gash, a knife is thrust into the tree slopingly, so that the water runs along the cut or gash, as through a gutter, pervades the knife, and falls upon some vessels placed underneath to receive it. The gash does no harm to the tree. Some trees will yield five or six bottles of this water in a day, and many inhabitants of Canada might draw twenty hogheads of it in one day, if they had a mind to notch all the maple trees upon their plantations; but common things are slighted, and scarce any but children think of extracting this liquor from the trees.

The mode of tapping is different, and is performed with an axe or an auger. The latter is preferred, from experience of its advantage. It is introduced about three quarters of an inch, and is afterwards deepened gradually to the extent of two inches. A spout is introduced about half

The above experiments clearly demonstrate, that it is not from heat and light alone that the sap rises in the vine, or any other tree; for, if that were the case, it would increase as the heat increased; it would be greatest in the noon-day, and in the height of summer, and less in spring than in autumn, whereas the reverse is here shewn to be the case. It must therefore depend on the irritability of the fibres composing the vessels, which gets exhausted by the stimulus of heat and light, and is accumulated by its absence. T.

an inch into the hole, and it projects from three to twelve inches. The operation of tapping is first done on the south side; and when the discharge of sap lessens, an opening is made with the auger on the north side, when an abundant flow takes place.

Wooden troughs large enough to contain three or four gallons are placed under the spout to receive the sap, which is carried every day to a large receiver made of wood. From this receiver it is conveyed, after being strained, to the boiler. The following facts have been ascertained by experiment: The sooner the sap is boiled, after it is collected from the tree, the better. The larger the vessel the more sugar is obtained. The sugar is also improved by straining the sap through blankets, or cloth, either before or after it is half boiled. Some fatty substance is added to the sap in the kettle, to prevent its boiling over. Lime, eggs, or new milk, is mixed with it in order to clarify it. I have seen clear sugar made without the addition of either of them. A spoonful of slack lime, the white of one egg, and a pint of new milk, are the usual proportions of these articles, which are mixed with fifteen gallons of sap. The maple sugar clarified with milk alone had the evident superiority of all others. After being sufficiently boiled, it is *grained*, and *clayed*, and afterwards *refined*, or converted into loaf sugar. The method of conducting each of these processes is so nearly the same with those which are used in the manufactory of West India sugar; and are so generally known, that I need spend no time in describing them.

There are two other methods of reducing the sap to sugar. The first is by *freezing*. This method was tried by Mr. Scott, a farmer in this state, with great success. He says, that one half of a given quantity of sap reduced in this way, is better than one third of the same quantity reduced by boiling. If the frost should not be intense enough to reduce the sap to the graining point, it may afterwards be exposed to the action of fire for that purpose.

Secondly,

Secondly, by *spontaneous evaporation*. The hollow stump of a maple sugar tree, which had been cut down in the spring, and which was found some time after filled with sugar, first suggested to our farmers this method of obtaining sugar. So many circumstances of cold and dry weather, large and flat vessels, and above all so much time is necessary to obtain sugar by either of the above methods, that the most general method among our farmers is to obtain it by boiling.

The kettles and other utensils of a farmer's kitchen will serve most of the purposes of making sugar, and the time required for the labour (if it deserves that name) is at a season when it is impossible for the farmer to employ himself in any species of agriculture. His wife, and all his children above ten years of age, may assist him. The following receipt was published in the Albany Gazette: "Received of William Cooper, Esq. sixteen pounds for 640 pounds of sugar, made with my own hands, without any assistance, in less than four weeks, besides attending to all the other business of the farm. John Nicholls."——A single family consisting of a man and his two sons, on the Maple Sugar Lands between the Delaware and Susquehannah, made 1800 pounds of maple sugar in one season. Not more knowledge is necessary for making this sugar, than is required to make cyder, beer, &c. and yet one or all of them are made in most of the farm-houses in the United States.

Let us now take a comparative view of this sugar with that obtained from the cane, with respect to its *quality*, *price*, and the *quantity* that might probably be made in the United States, each of which I shall consider in order:

1. The *quality* of this sugar is necessarily better than that which is made in the West Indies. It is prepared in a season when not a single insect exists to feed upon it, or to mix its excretions with it. The same observation cannot be applied to the West India sugar. The insects and worms which prey upon it, and of course mix with it, compose a page in a nomenclature of natural history. I shall say no-
thing

thing of the hands which are employed in making sugar in the West Indies; for slaves have not that obligation to cleanliness which those have who work for their own benefit, and have received a proper education. It has been conceived that the maple sugar is inferior to the West India sugar in strength. The experiments which led to this opinion I suspect have been inaccurate, or have been made with maple sugar prepared in a slovenly way. I have examined equal quantities by weight of both the grained and the loaf sugar, in hyson tea, and in coffee, made in every respect equal by the minutest circumstances that could affect the quality or taste of each of them, and could perceive no inferiority in the strength of the maple sugar. The liquors which were to decide this question were examined at the same time by Alexander Hamilton, Esq. secretary of the treasury of the United States, Mr. Henry Drinhur, and several ladies, who all concurred in the above opinion.

2. *Price.* Whoever considers that the gift of the sugar maple tree is from a benevolent Providence; that we have many millions of acres in our country covered with them; that the tree is improved by repeated tappings; and that the sugar is obtained by the frugal labour of a farmer's family; and at the same time considers the labour of cultivating the sugar cane, the capitals sunk in sugar works, the first cost of slaves and cattle, and the expences of provisions for both, &c. will not hesitate in believing that the maple sugar may be manufactured much cheaper, and sold at a considerably *less price* than that which is made in the West Indies.

3. The resources for making a sufficient *quantity* of this sugar, not only for the consumption of the United States, but for exportation, will appear from the following facts:—There are in the states of New York and Pennsylvania alone, at least ten millions of acres of land which produce the sugar maple tree in the proportion of thirty trees to one acre. Now, supposing all the persons capable of labour in a family to consist of three, and each person to attend 150 trees, and each

each tree to yield 5 pounds of sugar, the product of labour of 60,000 families would be 135,000,000 pounds of sugar, and, allowing the inhabitants of the United States to compose 600,000 families, each of which consumed 200 pounds of sugar a year, the whole consumption would be 120,000,000 pounds a year, which would leave a balance of 15,000,000 pounds for exportation. Valuing the sugar at 6—90 of a dollar per pound, the sum saved would be 8,000,000 dollars of home consumption, and the sum gained by exportation would be 1,000,000 dollars.

The maple sugar also affords excellent vinegar; its molasses is capable of affording a very pleasant summer beer. The sap is also capable of producing spirit; but we hope this wholesome juice will never be prostituted to such a purpose. A diet consisting of a plentiful admixture of sugar has many advantages.

Sugar affords the greatest quantity of nourishment in a given quantity of matter of any substance in nature. Hence the Indians use it in their excursions. They mix a certain quantity of maple sugar with an equal quantity of Indian corn, dried and powdered. This mixture is packed up in little baskets. A few spoonfuls of it mixed with half a pint of spring water, afford them a pleasing and strengthening meal. From the great degree of strength and nourishment which are conveyed into animal bodies by a small bulk of sugar, it may be given to horses with great advantage. A pound of sugar with grass or hay, I have been told, has supported the strength and spirits of a horse during a whole day's labour in one of the West India islands. A larger quantity given alone has fattened horses and cattle during the war before last in Hispaniola, for a period of several months, in which the exportation of sugar and the importation of grain were prevented by the want of ships.

3. A plentiful use of sugar is the best preventative of worms. The author of nature seems to have implanted a love for sweets in all children for their growth, and to ward off the disease of worms.

4. I think it probable, that the frequency of malignant fevers of all kinds has been lessened by this diet, and that its more general use would defend that class of people who are most subject to malignant fevers from being so often affected by them.

5. It has been said, that sugar injures the teeth; but this opinion now has so few advocates, that it does not merit a serious refutation.

It has been a subject of enquiry, whether the maple sugar might not be improved in its quality, and increased in its *quantity*, by culture. From the influence which culture has upon forest and other trees, it has been supposed, that by transplanting the maple sugar tree into a garden, or by destroying such other trees as shelter it from the rays of the sun, much advantage might accrue. I know but of one fact. A farmer in Northampton county, in the state of Pennsylvania, planted a number of these trees above twenty years ago in his meadow, and he declares that the quality is so improved, that from three gallons of the sap he obtains every year a pound of sugar; and it is a known circumstance that, to produce the same quantity of sugar from the trees which grow wild in the wood, it requires five or six gallons of sap. To transmit to future generations all the advantages which have been here enumerated, it is necessary that this tree should be cultivated in the old and improved parts of the United States, and a bounty given upon the maple sugar by Government. Afterwards men would find out their own advantage in rearing them. An orchard consisting of 200 trees, planted upon a common form, would yield more profit than the same number of apple or any other trees. If a greater exposure of a tree to the action of the sun has the same effect upon the maple that it has upon other trees, a larger quantity of sugar might reasonably be expected from each tree planted in an orchard. Allowing it to be only seven pounds, then 200 trees will yield 1400 pounds of sugar; and deducting 200 from the quantity for the consumption of the family, there will remain for sale 1200 pounds,

pounds, which at 6—90 of a dollar per pound will yield an annual profit to the farmer of 80 dollars. Should this mode of transplanting for the purpose of obtaining sugar be successful, it will not be a new one. The sugar cane of the West Indies was brought originally from the woods of the East Indies by the Portuguese, and cultivated at Madeira, from whence it was transplanted directly or indirectly to all the sugar islands of the West Indies.

In contemplating the present opening prospects in human affairs, I am led to expect that a material share of the happiness which Heaven seems to have prepared for all mankind, will be derived chiefly from the manufactory and general use of the maple sugar, which I flatter myself will not be confined to us, but will extend itself to other nations. With this view of the subject, I cannot help contemplating a sugar American maple tree with a species of affection and even veneration; for I have persuaded myself to behold in it the happy means of rendering the commerce and slavery of our African brethren in the West India islands as unnecessary as it has always been inhuman and unjust *.

XV. *An Account of Mr. PARK'S Journey into the Interior Parts of Africa. From the Proceedings of the African Association, 1798.*

THE account of the proceedings of the African Association, from which the following extract is taken, though it abounds with many curious particulars which we have been obliged to omit, contains but a small part of the information obtained by Mr. Park during the course of his peregrinations in the wild regions of Africa. A detailed relation of

* The friends to the abolition of the Slave Trade should not allow the information contained in this article to escape their notice. It would require very little expence or industry to introduce the sugar maple into England, where it would probably thrive as well as in America. T.

this enterprising traveller's journey, and of the discoveries he made, is reserved for a large volume, to be published by subscription, which we are happy to find announced, and we have no doubt that the author will meet with that reward from the public to which he is so justly entitled by his fortitude and perseverance. We cannot help observing also, that great thanks are due to the African Association, for their exertions to procure information respecting the continent of Africa, and thus to pave the way for the civilisation of its inhabitants. The Report printed for the use of the members does great credit to the literary talents of Bryan Edwards, Esq. by whom it was drawn up.

On the 22d of December 1795, Mr. Park took his departure from the house of his friend Dr. Laidley, at Pisania, on the banks of the river Gambia, and directed his course easterly for the kingdom of Woollî. He was accompanied by two negro servants, natives of the country, one of whom spoke English tolerably well, and served him as interpreter; the other was a boy presented to him by Dr. Laidley. He had also a horse for himself, and two asses for his servants. His baggage consisted chiefly of provisions for two days, a small assortment of beads, amber and tobacco, for the purchase of a fresh supply as he proceeded: a few changes of linen and other necessary apparel, an umbrella, a pocket sextant, a compass, and a thermometer, together with two fowling-pieces, two pair of pistols, and some other small articles.

Mr. Park reached Medina, the capital of Woollî, on the third day, and was received by the sovereign or chief, named Jatta, with much kindness. This prince wished to persuade Mr. Park not to prosecute his journey any farther, by pointing out the dangers and difficulties he would have to encounter; but finding his remonstrances had no effect, he furnished him with a guide to Bondon, and suffered him to depart.

Leaving Medina, Mr. Park proceeded onwards, and on

the 21st of December reached Fatteconda, the capital of the kingdom of Bondou. The king of this country was a Pagan, like that of Woolli: but he had adopted the Moorish name of Almami, and seems also to have imbibed somewhat of the Moorish disposition; for though Mr. Park presented to him his umbrella and some other articles, he compelled him to strip in his presence and surrender his coat, which he said he should reserve for his own wearing on great and public festivals. In return, however, he gave our traveller five drachms (*minkallies*) of gold dust, and loaded him with provisions.

Departing from Fatteconda on the 23d of December, Mr. Park proceeded the two following days to a place called Joag in the kingdom of Kajaaga, a country bounded on the north by the Senegal river. The natives are called Sera-Woollies, and seem to be pure negroes. The appearance of a white man among them excited great curiosity. The king commanded that he should be brought before him; and it was with some difficulty that Mr. Park, who had been cautioned to avoid him, declined the interview, and got out of his dominions with the loss of about one half of his goods and apparel.

The name of this rapacious chief was Bacheri. He had recently fallen out with a neighbouring prince, the sovereign of Kasson, a country to the north-east; and it happened that the king of Kasson's nephew was in Bacheri's capital, endeavouring, but in vain, to effect a reconciliation at the time of Mr. Park's arrival at Joag. This young man, finding that our traveller proposed proceeding to Kasson, kindly offered to take him under his protection. They accordingly set out together, and, after a journey of two days, crossed the river Senegal at Kayee, the frontier village of the king of Kasson's dominions, near which that river ceases to be navigable. From Kayee Mr. Park was led by his friendly conductor to Teesee, the place of his abode, and the residence of the king's brother Tigetee-Sego, an old man of a

venerable aspect, but of a selfish disposition. He had never seen, he said, but one white man before, and, on describing him, it was known to be Major Houghton. The circumstance of having a white man under his roof was highly gratifying to the vanity of Tigetee-Sego, on account of the great number of the natives who resorted to see him. He therefore compelled our traveller to remain with him twelve days, and afterwards to take a journey of two days more to present himself to the king at his capital of Kooniakary, who detained him another fortnight, but in other respects behaved to him with great kindness and hospitality. Of this prince, whose name was Demba Sego Jalla, Mr. Park received the first certain account of Major Houghton's death.

Being permitted at length to leave the capital, Mr. Park prosecuted his journey eastward, and in five days arrived at Kemnoo, a large and populous town (since destroyed), at that time the metropolis of Kaarta. The sovereign, whose name was Dayfi Koorabarri, received Mr. Park with great kindness. Major Houghton was the only European he had ever before seen, and he had conceived the highest idea of the superiority of the whites to the blacks in all possible respects. The language of the country seemed to Mr. Park to be a mixture of the Mandingo and Sera-Woolli: but the pure Mandingo, in the attainment of which Mr. Park by this time had made considerable proficiency, was very generally understood, and with very little assistance from his interpreter he found no difficulty in conveying his own sentiments, and comprehending others.

Having informed the king that he proposed going to Bambara in search of the Joliba river, which was believed to take its course through the centre of that extensive kingdom, he was told that, the Bambarans being at that time in a state of warfare with the Kaartans, he could not without extreme personal danger venture into the Bambaran country. His only safe route was a northerly course to Ludamar, a territory of the Moors in alliance with Mansong the king of
Bainbara;

Bambara; from whence, passing as a traveller from the Moorish country, he might venture, by a circuitous journey; to Bambara. To this advice being obliged to submit or give up all thoughts of prosecuting his journey in search of the Niger, the king, as the last proof of his kindness, sent eight horsemen to convey him in safety to Jarra, the frontier town of the Moors, where he arrived on the 18th of February 1796. In the course of his journey he passed through a village not far from Jarra, called Simbing, from whence Major Houghton wrote his last dispatch with a pencil.

The territories which our traveller had hitherto explored, being very generally clothed with native woods, presented to the eye the appearance of great uniformity. In his progress eastward the country rose into hills, and the soil varied to a considerable degree; but wherever the land was cleared, great natural fertility was observed. Bondou in particular may literally be pronounced "a land flowing with milk and honey." Both these articles, together with rice and Indian corn of two or three species, were to be obtained at a small expence. Of their honey, the Pagan natives make an intoxicating liquor, much like the mead of Europe. The price of a fowl in Bondou was a button, or a small bit of amber; goat's flesh and mutton were proportionably cheap; and for six or eight amber beads Mr. Park might at any time have purchased a bullock. The domestic animals are nearly the same as in Europe: the Guinea fowl and red partridge abound in the fields; and the woods furnish a small species of antelope, of which the venison is highly and deservedly prized.

Of the other wild animals in the Mandingo countries the most common are, the hyæna, the panther, and the elephant. But the natives of Africa have not yet acquired the art of taming the last-mentioned animal, notwithstanding his strength and docility, so as to render him serviceable to man; and when Mr. Park told some of them that this was actually done in the countries of the East, his auditors laughed, and exclaimed, "*Tobaubo sonnio!*" A white man's

lie! —The negroes frequently find means to destroy the wild elephant with fire-arms; they hunt it principally for the sake of its teeth, which they transfer in barter to those who sell them again to the Europeans.

The pastures of Bondou furnish an excellent breed of horses, but the usual beast of burthen in all the negro territories is the ass. The application of animal labour to the purpose of agriculture is wholly unknown. The chief implement used in husbandry is the hoe, which varies in form in different districts; and the labour is universally performed by slaves. Besides the grains proper to tropical climates, the Mandingoes cultivate in considerable quantities ground-nuts, yams, and pumpions. They likewise raise cotton and indigo, and have sufficient skill to convert these materials into tolerably fine cloth of a rich blue colour: and they make good soap from a mixture of ground-nuts and a ley of wood-ashes.

The town of Jarra, at which Mr. Park had now arrived, is situated in the kingdom of Ludamar, a Moorish country, of which it is not known that any account has ever been given in any of the languages of Europe. The town itself is extensive, and the houses are built of clay and stone intermixed; but the major part of the inhabitants are negroes from the borders of the Southern States, who prefer a precarious protection under the Moors, which they purchase by a tribute, to being continually exposed to their predatory hostilities.

During his stay at Jarra, Mr. Park resided at the house of a Slatee trader, named Daman, who was known to Dr. Laidley. By him Mr. Park was informed that he could proceed no farther on his way to Bambara, without leave from Ali, the Moorish chief or king of the country, who was then encamped at a place called Benown; and that it was absolutely necessary that a present should accompany the application by which permission was to be obtained. Mr. Park therefore purchased five garments of country cloth, by the sale

sale of one of his fowling-pieces. Damian undertook to negotiate the business, and at the end of a fortnight permission arrived from Benowm.

This permission was brought by one of Ali's own slaves, who said he was ordered to serve Mr. Park as a guide to Bambara; and on the 27th of February he took his departure from Jarra, accompanied by this slave, his own faithful boy, and a negro belonging to Damian; the interpreter refusing to proceed any farther.

On the third day after his departure from Jarra they reached a large town called Deena; on entering which Mr. Park was surrounded by many of the Moorish inhabitants, who harassed him with shouts of insult, spit in his face, and seized his baggage, which they robbed of what things they fancied. He got refuge, at length, in the house of a negro; and after experiencing much difficulty in persuading his attendants to proceed any farther, he set out on the second day for Sampaka. Here he procured lodging at the house of a negro, who understood the art of making gunpowder. The nitre was obtained in considerable quantities from the swamps or ponds, which are filled in the rainy season, and to which the cattle resort in the heat of the day for coolness. As the water of these ponds is slowly exhaled by the sun, the nitre appears in a white efflorescence on the mud, and is carefully scraped off in the form of small crystals. Sulphur is purchased of the Moors, and the several ingredients are blended together in such proportions as experience has shewn will answer the purpose; though the powder thus made is far inferior to that of Europe.

On the morning of the 7th of March, Mr. Park had reached a small village called Sami, within two days journey of Goomba, the frontier town of Bambara; and was resting himself in the hut of a friendly negro, pleased with the hopes of being soon out of danger, when he was alarmed by the arrival of two Moors, who announced that they came by order of Ali to convey him to the camp at Benowm. They

added, that, if he consented to go with them peaceably, he had nothing to fear : but that, if he refused, they had orders to carry him by force.

Finding entreaty and resistance equally fruitless, for the messengers were joined by others, all of them armed, our traveller, guarded by the Moors, and accompanied by the negro boy (Daman's negro having made his escape on seeing the Moors, and the slave sent by Ali having previously left him on the road), set out on the evening of the same day for the camp at Benown, which after a distressing journey they approached on the 12th. It presented to the eye a multitude of dirty-looking tents, scattered without order over a large space of ground ; and among the tents were seen herds of camels, bullocks, and goats.

The arrival at the camp of a white man was no sooner made known, than all the people who were drawing water at the wells threw down their buckets, those in the tents mounted their horses, and men, women and children came running or galloping towards him. He soon found himself surrounded with such crowds that he could scarcely walk ;—one pulled off his clothes—another took off his hat—a third stopped him to examine his waistcoat buttons—and a fourth called out “ *La illa ill Allabi, Mahomed rasowl Allabi ** ; and signified in a threatening manner that he must repeat these words. He at length reached the tent of the king, whom he found sitting upon a black leather cushion, clipping a few hairs from his upper lip, while a female attendant held up a looking-glass before him ; there were many other females in the tent. The king appeared to be an old man of the Arab cast, with a long white beard. He had a fullen and indignant aspect, and looking at our traveller with attention, enquired of the Moors if he could speak Arabic ; but being answered in the negative, he appeared much surprised, and continued silent.

* “ There is no god but God, and Mahomet is his prophet.”

The surrounding attendants, and particularly the ladies, were far more curious and inquisitive. They asked a thousand questions, inspected every part of Mr. Park's apparel, searched his pockets, and obliged him to unbutton his waistcoat and display the whiteness of his skin, &c. They even counted his toes and fingers, as if they doubted whether he was in truth a human being. When the curiosity of the ladies was in some measure satisfied, he was conducted to the tent of Ali's chief slave; into which however he was not permitted to enter, nor allowed to touch any thing belonging to it. He requested something to eat, and some boiled corn with salt and water was at length sent him in a wooden bowl; and a mat was spread out on the sand before the tent, on which he passed the night, surrounded by the curious multitude. A hut was afterwards erected, in which he was confined and strictly guarded.

Some time after a ludicrous circumstance took place, which would not deserve attention did it not tend to throw some light on the national manners of the people among whom our traveller resided. Hearing one morning the sound of drums, Mr. Park was informed that the noise was occasioned by the celebration of a wedding in one of the neighbouring tents. Soon after an old woman entered his hut with a bowl in her hand, and signified that she had brought him *a present from the bride*. Before he could recover from the surprise occasioned by this message, the woman discharged the contents of the bowl full in his face. Mr. Park finding that it was the same sort of *holy water* as that with which the priest among the Hottentots is said to besprinkle a new-married couple, he began to suspect that the old lady was actuated by mischief or malice: but she gave him seriously to understand that it was *a nuptial benediction from the bride's own person*, and which, on such occasions, is always received by the young unmarried Moors as a mark of distinguished favour.

The Moorish ladies seemed indeed to commiserate his condition,

condition, and one of them once privately sent him a small supply of meal and milk; but their kindness extended no farther. If they pitied his situation, it is probable that they dared not administer to his wants; and his distress at length became almost insurmountable. He was allowed a single meal of *kouscous*, a preparation of boiled corn, once in twenty-four hours. All his effects were taken from him, and he was not even indulged with a change of linen out of the few shirts he had brought in his portmanteau: oppressed at the same time with a burning fever, his situation was truly deplorable. "In this condition, from sun-rise to sun-set," says he, "was I obliged to suffer with an unruffled countenance the insults of the rudest savages on earth.

In eight or ten weeks, however, circumstances occurred, which, contrary to their first appearance, changed our traveller's situation for the better, and in the end produced his deliverance. In the war which prevailed between the kings of Bambara and Kaarta, the Moors at first took no active part; but Ali having afterwards engaged to send 200 horse to the assistance of the fugitive Kaartans, he became panic-struck at the approach of the king of Bambara towards Senegal: broke up his camp, and fixed his tent in a country to the north. Mr. Park was compelled to follow him, and, after a month's confinement at the new camp, was led by Ali to Jarra. At this place he had the mortification to see the poor boy who had attended him from the Gambia taken from him, by Ali's command, for the avowed purpose of being sold into slavery. After this cruel circumstance, and the certain information which he received from Ali's own son (a youth of ten years of age, who had conceived something like friendship for Park, or pity for his misfortunes), that it was in contemplation to deprive Park himself of his life, or put out his eyes, he determined rather to risk perishing in the woods, of hunger, or by the fury of the wild beasts, than to remain any longer with a horde of faithless barbarians, whose tenderest mercies were cruelty, and from whose

whose caprice or fanaticism he was in hourly danger of destruction.

On the morning of the 1st of July 1796, Mr. Park was so fortunate as to break the bonds of his captivity. He had contrived to procure at his departure his own horse, saddle and bridle; a few articles of apparel, and also his pocket compass. This last he had concealed in the sand during his confinement. He rode forwards the whole of the first day without stopping. "I felt," said he, "like one recovered from sickness; I breathed freer; I found unusual lightness in my limbs. Even the desert looked pleasant; and I dreaded nothing but falling in with some wandering parties of Moors, who might convey me back to the land of thieves and murderers, from which I had just escaped."

The first emotions of his mind subsiding however into sober reflection, he soon found his condition to be very deplorable. His horse grew tired, and he experienced the torments of thirst raging beyond description. Whenever he came to a tree, he climbed it in hopes of discovering a watering-place, but in vain; he chewed the leaves, but found they were all bitter, and afforded no relief. In a vast wilderness of the African continent, without an attendant or guide, without food and water, or the prospect of procuring any; in a country where the lion and panther prowling for their prey are less to be apprehended than man, what situation could be more forlorn and dreadful? He proceeded onwards, however, directing his route nearly east-south-east, in the view of reaching by the shortest course possible a district that might afford him shelter. A heavy rain about midnight enabled him to quench his burning thirst, by spreading his clothes on the ground and sucking the moisture out of them; and a muddy pool, which he found soon after, yielded relief to his horse. The rest of the night, and nearly the whole of the ensuing day, neither water nor food was to be found: and he must inevitably have perished, had he not fortunately towards evening, lighted upon a few scattered huts of some Foulah

Foulah shepherds. Perceiving an aged negro woman among those who gazed at him with great earnestness, he tendered her his pocket handkerchief, and requested in exchange a little corn to eat. She gave him a kind answer, invited him to her hut, and immediately produced a large wooden bowl of *kouscous* ready prepared. She procured likewise some corn and water for the horse*. Those only who have suffered similar misery can judge of his sensibility at this unexpected deliverance. But as the village belonged to the Moors, our traveller had only a short time to rest. As he approached the territories of the negroes, however, his apprehensions diminished, and his condition improved.

Procuring precarious support in this manner from the charity of the most wretched of human beings, Mr. Park wandered for the space of fifteen days, still however proceeding onwards in the accomplishment of his mission. At length, in the morning of the sixteenth day, having been joined by some Mandingo negroes, who were travelling to Sego, he had the inexpressible satisfaction to behold the great object of his wishes—the long-sought majestic Niger glittering to the morning sun, as broad as the Thames at West-

* It is worthy of remark, and highly to the credit of the female sex, that Mr. Park seems invariably to have met with compassion and relief from women. This perfectly accords with the account given by another enterprising traveller, Mr. Ledyard, who expresses himself as follows: "I have always remarked that women in all countries are civil, obliging, tender and humane; that they are ever inclined to be gay and cheerful, timorous and modest; and that they do not hesitate, like men, to perform a generous action. In wandering over the barren plains of *inhospitable Denmark*; through *honest Sweden*, and *frozen Lapland*, rude and *churlish Finland*, *unprincipled Russia*, and the *wide-spread regions of the wandering Tartar*, if hungry, dry, cold, wet or sick, the women have ever been friendly to me, and uniformly so: and to add to this virtue, so worthy the appellation of benevolence, these actions have been performed in so free and so kind a manner, that if I was dry I drank the sweetest draught, and if hungry I ate the coarse morsel with a double relish." EDIT.

minster, and flowing majestically but slowly from west to east, through the middle of a very extensive town, which his fellow-travellers told him was Sego, the capital of the great kingdom of Bambara. His emotions at this sight were exquisite, and it were unjust not to give them in our traveller's own words: "I hastened," says he, "to the brink of the river, and, having drank of the water, lifted up my fervent thanks in prayer to the Great Ruler of all things, for having thus far crowned my endeavours with success."—Unhappily, he had yet to sustain many severe and bitter trials of his patience and fortitude.

Information of a considerable river flowing through the centre of Africa, between the latitudes of 15° and 20° north, had been received at very early periods from different quarters. At one time it was believed to be a part of the Senegal. The Gambia had the same honour ascribed to it at another. But sufficient proof was afterwards obtained that neither of these rivers was the Niger, and further enquiries confirmed the ancient accounts of a stream that was not only of greater magnitude than either the Senegal or the Gambia, but which flowed in a *contrary direction*; running not to the westward into the Atlantic, but from west to east, to regions unknown. The Moors described it by the name of *Nil il Abeed*, or the River of Slaves: the negroes bestowed on it the appellation of *Joliba*, or the Great Waters.

Some doubt however still remained. It was urged that the Moors might possibly speak of one river, and the negroes of another; and the account of its direction towards the east was received by our ablest geographers with much difficulty and hesitation. On both these points Mr. Park's testimony is clear and decisive; the Moors, in his hearing, uniformly called it *Nil il Abeed*; the inhabitants of Sego, the *Joliba*; and that it flowed from west to east, he had ocular demonstration in a long and perilous ambulation of some hundred miles, which he afterwards made on its banks. Thus therefore is all further question obviated concerning the

the existence and direction of this great river; but its termination still continues unknown.

[To be concluded in the next Number.]

XVI. *Analysis of the Emerald of Peru.* By M. VAUQUELIN. *From the Annales de Chimie, Vol. XXVI.*

SEVERAL celebrated chemists have already analysed the emerald; but, as I am convinced that science is promoted and individuals instructed by repeating the labours of those who have preceded us, I have again subjected this fossil to a chemical analysis. Klaproth, one of the most accurate analysts of modern times, found in the emerald of Peru siliceous earth 66.25, alumine 31.25, oxyde of iron 0.50. It will be seen in the course of this short memoir, that the result of my labour differs from that of the Prussian chemist, not only in the proportion of the constituent principles, but in their number, and the nature of some of them*.

Exp. I. This stone, broken into small fragments, and exposed to a strong heat, lost a part of its beautiful green colour, and retained only a light shade of it. In many places of it there were cracks; and it lost of its weight 0.02 grains.

Exp. II. Two hundred parts of this fossil, which answered to 200 grains, *poid de marc* (eight ounces to the pound), or 10.615 grammes, were melted for an hour in a silver crucible with 600 parts of caustic potash. The matter had then a greenish yellow colour. This solution, when evaporated to a quarter of its bulk, was converted into a green jelly, the shade of which was much weakened by desiccation.

The residue was diluted in a large quantity of water; and it was observed, that the first portions of this liquid, poured

* According to the first analysis of the emerald, the results of which I presented to the National Institute, I found in it siliceous earth, alumine, lime, and the oxyde of *chrome*; but since that epoch, having discovered a new earth in the beryl, or *aigue marine*, I repeated my analysis, under this new point of view, and I found also that particular earth, as will be seen in the course of this memoir.

upon the substance, made it assume a bright and very agreeable green colour. The solution of the salt had also the same shade, but weaker. There remained a white insipid substance, full of grains, which was insoluble in water, and had all the properties of siliceous earth. It weighed 129 parts, after having been exposed to a red heat.

Exp. III. To the liquor of the second experiment, from which the siliceous earth had been separated, I added caustic potash, more than necessary for saturation, and then boiled it for some time. The greater part of the matter precipitated was at first re-dissolved; but there remained a certain quantity which obstinately resisted solution. The solution having been filtered, the insoluble matter, which, when washed and dried, weighed seven parts, was collected on the filter.

This matter had a light lilac colour, which became green by the heat of the blow-pipe. When melted with borax and the fusible salt of urine, it gave them a superb green colour, perfectly like that of the emerald. This property of thus giving a green colour to borax and microcosmic salt, made me abandon the idea I had first conceived, that this matter might be the oxyde of nickel; since the oxyde of that metal, though green, communicates to borax a hyacinth colour. As this colour had a perfect resemblance to that which I obtained from the oxyde of the metal* contained in the red lead of Siberia, I directed my experiments with a view to establish that resemblance. I therefore took this colouring matter, drawn from the emerald, and boiled it to dryness with concentrated nitric acid. I then poured upon the residue caustic potash, and obtained a solution of an orange-yellow colour; which when mixed with a solution of the nitrate of lead immediately produced the red lead of Siberia, and gave, with the nitrate of mercury, a precipitate of a vermilion red colour, absolutely in the same manner as does the acid of the red lead.

* Vauquelin's account of this new metal, called *Chrome*, will be given in our next number. EDIT.

These experiments, though not numerous, are sufficient to prove, that the colouring matter of the emerald of Peru is not iron, as announced by Klaproth, but that it is, on the other hand, the oxyde of the new metal which I discovered in the red lead of Siberia. One thing, however, which ought to surprise those acquainted with the sagacity and accuracy which the chemist of Berlin shews in his labours, and which have gained him so high reputation, is, that he did not observe this substance, so easily to be distinguished by a great number of characterising marks, entirely different from those exhibited by other minerals. I shall now proceed to other principles of the emerald.

Exp. IV. The reader will recollect that the liquor of the second experiment, deprived of its filiceous earth, was precipitated by caustic potash, and that the precipitate was, in great part, re-dissolved by an excess of this alkali. This solution was then supersaturated with the muriatic acid, and carbonate of potash used in commerce was poured over it. This produced a very abundant precipitate, which, being washed, and exposed to a red heat in a silver crucible, weighed fifty-four parts.

These fifty-four parts were dissolved in the sulphuric acid; and the solution, by the addition of a little potash at intervals, gave, by several successive crystallisations, 149 parts of alum crystallised in octaedra, among which there were eight or nine parts of the sulphate of lime; but as these 140 parts of alum contained only about twenty-six parts of pure alumine, and as the mother-water, the taste of which was exceedingly saccharine, gave no more alum by the addition of a new quantity of potash, I diluted it in water, and mixed with it a solution of the carbonate of ammoniac, until there was an excess. I shook this mixture from time to time, for several hours; at the end of which the greater part of the precipitate, which had been at first formed, was dissolved.

I then filtered the liquor, and collected on the paper the undissolved matter, which, when washed and dried, weighed

two parts, and exhibited all the properties of alumine. The liquor, being exposed to the action of fire, deposited, some moments after, a white insipid dust, full of grains, which dissolved with an effervescence in acids. Being collected with care, washed, and made red-hot, it weighed twenty-six parts. This substance, subjected to different tests, exhibited all the characterising marks of that earth which I found in the beryl; the properties of which I explained at large in a memoir inserted in the preceding number of the *Annales*, and which has obtained the name of *Glucine*.

It appears from the experiments announced in the course of this analysis, that 100 parts of the emerald of Peru consist of

1st, Siliceous earth	-	-	-	64.60
2d, Alumine	-	-	-	14.00
3d, The particular earth, or <i>glucine</i>			-	13.00
4th, Lime	-	-	-	2.56
5th, The oxyde of <i>chrome</i>		-	-	3.50
6th, Moisture, or other volatile matter			-	2.00
				<hr/>
				99.66
				<hr/>

It appears then by the result of this analysis, that there is a very great difference between the proportion, the number, and the nature of the principles which constitute the emerald, and those found by Klaproth; since, according to him, it is composed of only 66.25 of siliceous earth, 31.25 alumine, and 0.50 of the oxyde of iron. There are in this stone then three substances not observed by the above chemist, viz. *glucine*, the oxyde of *chrome*, and lime; while the oxyde of iron, which he announces, does not exist in it.

It follows therefore from this result, that the emerald and the beryl are two stones perfectly similar, and composed of the same principles, the colouring matter excepted; and mineralogy had already got the start of chemistry by bring-

ing together these two fossils, and making them only one species*.

XVII. Cursory View of some of the late Discoveries in Science.

[Continued from the last Number, p. 65.]

METEOROLOGY.

METEOROLOGY, which depends only on an immense number of observations, has, however, been exalted into a science. It affords general results of great importance; a collection of which has been made by Cotte. By these it appears that the barometer varies very little under the equator. Its variation becomes greater in proportion as it approaches the poles. It seems to experience a diurnal and an annual variation.

Diurnal variation.—Between the hours of ten and two, both of the day and the night, the risings and fallings of the mercury are the least. The contrary takes place between the hours of six and ten of the morning and evening. This seems to depend on the sun and the moon passing the zenith.

Annual variation.—The oscillations are less in summer, greater in winter, and very great at the equinoxes. This seems to depend, like the tides and the winds, on the same action of the sun and the moon.

Thermometers.—The mean degrees of heat are almost the same in all latitudes. Kirwan has given a table for calculating the mean degrees of heat in different latitudes.

Rains are more frequent in winter than in summer; more abundant in summer than in winter. Mean quantity of rain at Paris twenty-two inches. The evaporation generally exceeds the rain at Paris. The mean evaporation is thirty-three inches.

Aurora borealis is more frequent about the time of the equinoxes than at any other season. This phenomenon is

* See Abbé Haüy on Crystallisation.

almost continual in winter in the polar regions. For some years past it seems in our climates to have become less frequent.

Lunar period of nineteen years.—It appears that the general temperature of a year returns the same every nineteen years, an epoch when the phases and position of the moon, in regard to the earth, are also the same. From the above period, therefore, we may predict, very nearly, the temperature of any given year. This method is practised by the makers of almanacks; and their predictions, to a certain degree, may be depended on. This mode of calculation is well known also to merchants who speculate in the price of provisions.

Maurice at Geneva makes meteorological observations of the utmost importance, because he has thermometers placed at different heights above the surface of the earth, as Picet had formerly, and others at the depth of four feet below it. He gives an account, therefore, of the evaporation of the earth, electricity, humidity, &c. His observations appear every month in an excellent collection, published by the brothers Picet, under the title of *Bibliothèque Britannique*. It appears that the thermometer, which is four feet below the earth, stands generally between 9° and 10° Reaum. (52° and 54° Fahr.) and that it experiences very little variation.

ZOOLOGY.—Great attention has been paid to the natural history of animals. Cuvier has published a number of memoirs on zoology, and some have been published also by Geoffroy. Daubenton proposes to divide the animal kingdom into eight classes:—1st, viviparous quadrupeds, of which he reckons 415; 2d, cetaceous animals 15; 3d, birds 2,424; all these animals have two ventricles in the heart: 4th, oviparous quadrupeds, of which he reckons 113; 5th, serpents 175; 6th, fishes 866; all these animals have only one ventricle in the heart, and their blood is almost cold: 7th, insects, of which he reckons 15,000; their heart is of

different forms; their blood is white; they have tracheæ, and breathe by stigmata: 8th, worms, of which he reckons 1,159; their heart is of different forms, their blood is white, and they have no apparent entrance for the air.

Cuvier and Geoffroy have made several interesting researches in regard to that class of animals called mammalia. The former, in a memoir on the rhinoceros, has proved that the two kinds known by Camper, viz. that of Asia and that of Africa, may have one, two, or three horns. The horns, therefore, cannot be a characterising mark to distinguish them. The distinguishing mark, however, of the African rhinoceros is, that it has only twenty-eight *dentes molares*, while that of Asia has twenty-eight *molares* and six *incisores*. He is of opinion also, that there are at least two other species in existence, and perhaps a third.

Camper has proved also, that the African elephant is different from that of Asia. The teeth of the latter are composed of transversal zones, and those of the African elephant represent on their surface a kind of trefoils or lozenges. It appears, that besides these two species there exist two others, and perhaps three. Syedianr says, that the greater part of the elephants' tusks used in commerce are collected in the immense pastures of Africa, where these animals feed, and that the negroes set fire to the meadows in order to discover them.

Audibert proposes to give a history of apes. He has already published one number, containing six coloured plates, folio size.

Birds.—Le Vaillant has already published a part of his *Natural History of the Birds of Africa*, consisting of five numbers, each containing six coloured plates, in folio and quarto. He has announced that the whole work will contain 600 plates. An edition in twelves, with some plates, will appear also. The two first volumes will be published without delay. He proposes to give a complete history of birds.

Fishes.

Fishes.—Bloch has published the last six volumes of his beautiful work on fishes. They contain, like the former six, 216 plates, on several of which are represented from two to three subjects. He has been obliged to make several new genera. This is one of the most beautiful works that ever appeared on ichthyology.

Lacepede is preparing a large work on the same subject. He has shewn that the anableps, a fish hitherto believed to have had four eyes, has in reality only two; but each of its eyes has two cornæ, two cavities for the aqueous humour, two irides, two pupils, but only one crystalline humour. Different naturalists have published separate memoirs on some particular kinds of fish, and their different parts. Herbst has published at Berlin a very beautiful work on crabs, with coloured plates.

Insects.—This part of natural history is become almost as immense as botany. Brogniard continues his superb collection of the butterflies of Europe. Fabricius has given a new edition of his *Entomologia Systematica, emendata et aucta*. Latreille has published his *Genera of Insects*, and D'Anthoine has published an excellent memoir on the cynips (gall insect) of the oak. Bosc has described some other species of the cynips, and Luce has described a phosphorescent beetle, found near De Grasse.

Panzer is now publishing a work on the insects of Germany, entitled *Fauna Insectorum Germaniæ*, printed at Nuremberg. He has published also a history of the insects of America. Ræusichel has printed a work at Leipzig, entitled *Nomenclator Entomologicus emendatus*. Hedwig has given a new edition of the *Fauna fislens Insecta*, by Rossi; in which are described the insects found in the neighbourhood of Florence and Pisa. Martin has published the *Insects of England*. This work, like that on shells, is executed in a masterly manner.

Polypiers.—There are certain substances which are neither animals nor vegetables, called *polypiers*; such as coral, coral-

lines, madrepores, &c. Girod Chantram has carefully examined some of these substances, which had hitherto been classed among the *cryptogamia* kind of plants: such as the *byssus*, *conferva*, *ulva*, *tremella*, &c.; and observed, that the greater part of them are composed of tubes or vessels, in which beings that appear to be animated circulate. He even distinguished in one species of *conferva* a real *volvox*, which had some similarity to the *rotator* of Gmelin.

These supposed plants, by a chemical analysis, give the same results as animal substances. He therefore concludes that they are not plants, but species of *polypiers*, formed, like coral, by small animals. Of these *polypiers* he distinguishes two kinds; some without tubes, and some which have tubes. We shall then have three orders of *polypiers*:—1st, The calcareous, such as corals and madrepores; the substance of which is hard and calcareous:—2d, Corallines, the substance of which is soft and flexible, like sponge:—3d, The *confervæ*, the substance of which is absolutely herbaceous. It is to be wished that naturalists would pay attention to the study of the insects which construct these different kinds of *polypiers*, as they are still unknown.

[To be continued.]

XVIII. *Biographical Memoirs of Peter Bayen. By M. LASSUS, Secretary to the Class of the Physical Sciences in the French Nat. Institute. From the Annales de Chimie, Vol. XXVI.*

PETER BAYEN, member of the National Institute in the section of chemistry, was born at Chalons in the department of la Marne, in the year 1725. His parents, observing that he had a happy disposition for learning, took the earliest opportunity to improve it, by sending him to the college of Troyes, where he studied the Latin language with the best success. Having terminated the course of his studies at that place, he turned his attention to natural philosophy, and, after acquiring the first principles of chemistry, soon became

became sensible that, to make any real progress in that science, the soundest judgment must be guided by a particular kind of knowledge not supplied by nature, and which can be obtained only by long and assiduous labour.

With a tolerable stock of knowledge, and a desire to obtain more, Bayen repaired to Paris, where he resided with an eminent apothecary, a friend of the celebrated Charras. The intelligence and happy dispositions of the pupil could not escape the penetration of the master, who, finding in this young man, fond of science, a character and taste similar to his own, treated him as his friend rather than a pupil, and procured him every means of instruction, by entrusting him with the management of his laboratory. His hopes were not disappointed: Bayen applied for several years to all the labours of pharmacy, and acquired so much skill in this art, that, before he had attained to the age of thirty, he was appointed chief apothecary to the army in Germany during the war of seven years. The duties of this office he discharged with a success worthy of the confidence which had been reposed in him; and he sought no other recompense for the fatigues he underwent, than the satisfaction of being useful in the hospitals.

After the peace he returned to Paris. At that period government was desirous of executing a plan it had been long meditating, which was, to cause an analysis to be made of all the mineral waters common in France. Rouelle, being appointed to make choice of the chemists capable of discharging that task, pointed out Bayen and Venel. They at first carried on their labours in conjunction, and published the result of their observations; but as an enterprise of this nature, to be completed, would require several years, and as particular circumstances obliged Venel to discontinue it, the whole devolved upon Bayen, who applied himself to it with the utmost assiduity.

He successively published various works, which contained much more extensive information respecting these mineral

waters than had ever been before known. The waters which he in particular analysed were those of Barreges, Bagneres, and Luchon. The analysis of the latter is a model of correctness which ought to be followed in works of this nature, and to which nothing could be added. This work, written in a very methodical manner, while it instructs the chemist and the physician, may be useful also to the naturalist and the philosopher, and even to the man of letters, by the interest which the author gives to a subject that appears to be little susceptible of it, and the variety of the details which it contains. It is to be wished that this grand enterprise, begun by Bayen and Venel, had been continued; but the funds set apart for the execution of it having been applied to other objects, it was at last dropped; and the knowledge respecting the mineral waters of France is still imperfect.

Bayen, in the course of his travels through the Pyrenees, had studied natural history, and been convinced of the necessity of analysing bodies, in order to acquire a knowledge of the substances which compose them. He therefore collected specimens of those minerals which seemed to be most deserving of particular attention; and these specimens in his hands became valuable materials for the ingenious analysis which he made of them, and in which he was employed for twelve years. To this immense labour the public is indebted for Bayen's different memoirs on marble, serpentines, porphyry, ophites, granites, jasper, argillaceous schists, and the sparry ore of iron, which he presented to the Academy of Sciences, and which that body caused to be inserted among those of the foreign literati.

Stahl, the oracle of chemistry, having maintained that one of the essential principles in nature is pure fire, or the matter which produces fire in combustible bodies, gave to this element thus combined the particular name of *phlogiston*, or the *inflammable principle*. Bayen, who in all his operations sought only for truth, and would not be convinced without evident proofs, because the habit of experience had rendered him mistrustful, began to doubt of the existence of phlogiston,

ton. He at first communicated his doubts to some friends, and then to the celebrated Macquer, who did not approve of them. The opinion of that learned man did not however discourage him; and he continued his researches. It was chiefly by examining precipitates of mercury that Bayen convinced himself fully of the falsity of Stahl's doctrine, and that he acquired a proof that every thing called *metallic oxyde* is indebted for the excess of its weight, its colour, and its state, only to the absorption of one of the constituent parts of the atmospheric air. With apparatus, which he invented, he made experiments so rigorously correct, that he was able to calculate the weight of this substance fixed in the metals.

When Bayen presented to the Academy of Sciences the result of the experiments above mentioned, Lavoisier, who was present, made metallic oxydes the object of his researches also. He repeated the experiments of Bayen; found them correct; discovered that a portion of the air drawn from metallic calces is much purer than that of the atmosphere; that this portion is the only part which can serve for combustion and respiration; and gave to this fluid the name of *vital air*. Lavoisier therefore, by removing entirely the veil which Bayen had only drawn a little aside, overturned for ever the theory of Stahl, and established one of the most memorable epochs in chemistry.

The various experiments which Bayen made, in the course of three years, on the precipitates of mercury, led him to a discovery of the singular property which some of these precipitates have of exploding with a loud noise, when mixed with a very small quantity of the flowers of sulphur. Bayen's labours also in regard to tin ought not to be passed over in silence. It was a question in chemistry, to determine whether that metal really contained arsenic, as Margraff and Henkel had said; and, supposing it did, whether the quantity would be sufficient to make the use of it be abandoned in economical purposes. The long and laborious researches of Bayen discovered that there exists tin without any mixture; and

that there exists some also, which is united to a very small quantity of the arsenical substance.

His analyses taught him also, that the tin used in commerce, and that manufactured by pewterers, contain copper and antimony, which render it hard; zinc, which gives it a white colour; bismuth, which renders it sonorous; and, above all, lead, which diminishes its value. It is in particular this metal fraudulently united with tin, that can render the latter dangerous*, as both these substances are soluble in vegetable acids. Scarcely had Bayen's researches on tin been made public, when the uneasiness excited by Margraff and Henkel vanished. It was clearly proved, that the very small quantity of arsenic contained in tin cannot absolutely be hurtful, and no more ideas were entertained of banishing a species of vessels so long employed by our ancestors.

Bayen had such a habit of considering objects, and of judging of their composition by the analyses he had made of analogous objects, that it was often sufficient for him to see and to touch them in order to tell their nature. As a proof of this assertion, may be mentioned the opinion which he gave of one of the marble balustrades in the *Place de la Revolution*. Notwithstanding the polish and apparent solidity of this marble, he foretold that it would decay in a very little time; and he pointed out to Deyeux, who was present, the different places where the alteration would first manifest itself, and those which would endure the longest. Scarcely had a year elapsed when the prediction began to be accomplished; and in less than three years the alteration was so great, that considerable excavations were formed in the places pointed out. Bayen was of opinion, that the monu-

* The pewter pots in common use in London contain lead in their composition; and as all the beer drawn in them is more or less acid (sale), it is evident that those who use them are constantly taking, though in small quantities, a solution of lead, which is highly noxious. It is very improper, therefore, to use beer which has stood in them for any length of time. EDIT.

ments which have subsisted without any perceptible alteration for a long series of ages, have been those constructed of marble, little susceptible of any attack from the action of the air or of water. From all the analyses which he made of marble belonging to ancient monuments, he concluded, that when a public edifice is to be erected, an architect cannot take too many precautions to be assured of the good state of the materials he employs, especially when they are brought from a quarry recently opened. By thus making an useful application of chemistry to an art which seemed to be foreign to it, he revived a truth, too little noticed, that there exists between all the sciences a connection which unites them by fixed and invariable principles.

Besides the labours above mentioned, Bayen began others, which, on account of the many experiments necessary before he could obtain certain results, were never finished; for he was of opinion that the operations of chemistry ought to be conducted slowly, like those of nature. On this account he has been known to employ himself whole years in the examination of one substance, in which he wished to discover and to separate a matter, that would have been destroyed or altered by too violent means, had he proceeded with more haste. To this prudent conduct was owing the great perfection to which he always carried his labours; and his accuracy was so great, that he was never afraid of seeing his experiments repeated by other chemists.

This diligent and laborious man, when he had attained to the age of sixty, found his health, which had hitherto been sound and robust, sensibly impaired by a long and painful malady. Several journeys which he was obliged to undertake, the loss of some friends, domestic troubles, and weakness brought on by his labours, hastened his death. He supported his complicated evils with great patience, and died in the beginning of the present year, at the age of seventy-two. Bayen lived in celibacy, but he possessed the virtue necessary for that condition. He was a man of a sound judgment,

ment, directed always by the force of reason and experience. In the distribution of the places which he had at his disposal, when inspector of hospitals with the army, he observed the most impartial justice; conferring them according to merit, and inexorable even to solicitations from his relations or friends. Chemistry did not occupy the whole of his attention, and the variety of the knowledge which he had acquired by his studies, rendered his conversation interesting and agreeable.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

IN the public sitting of the French National Institute, held on the 15th of Messidor (July 3), after an account had been given of the labours of the preceding three months, Cit. David Leroy read a memoir on the small ships of war of the Ancients, which he examined from the time of the first Punic war to the battle of Actium. He made choice of this epoch, as being that which presented the most remarkable improvements, and respecting which we have the most information. The author, in this memoir, points out the advantages of these vessels, which were exceedingly narrow in proportion to their length, several of them being eight and even ten times longer than they were broad, which allowed them, though pushed forwards by oars alone, to advance with great velocity. Cit. Leroi thinks that, notwithstanding the improved state of navigation, oars ought not to be so much neglected; and that ships of war like those used by the Ancients might still, especially during calms, be attended with great advantages,

A friend

A friend read for Cit. Delambre, who was then engaged near Carcassonne in measuring a degree of the meridian, an account of the means employed to measure, with the greatest accuracy, a portion of an arc between Melun and Lieusaint.

Cit. Fleurieu communicated some conjectures, perhaps too hypothetical, on the manner in which the north-west coast of America was peopled; together with a general view of that coast, and of both the Americas in regard to civilization. This memoir displays the extensive knowledge of its author.

Cit. Colin-Harleville recited a dialogue between a man and his own conscience. Several traits of sentiment were loudly applauded.

Cit. Chaptal communicated a memoir on yellow dyes, to which it has been as yet found impossible to give splendour and durability. The author pointed out the chemical means to be employed for accomplishing this object; and took occasion to shew the great obligation which the arts have to chemistry.

Cit. Mongez presented some reflections on two antique statues, the dying gladiator, and the *gladiator repellens*, or fighting gladiator; which are now on their way to embellish the Museum of Antiques, and of which beautiful copies in bronze may be seen at the entrance of the court of the Tuilleries. Cit. Mongez is of opinion that these two Greek statues do not represent gladiators, who were known only among the Romans, whom the people despised, and who were, however, seen with pleasure—but rather Grecian wrestlers. It is well known that the Greeks united in their wrestlers, those ideas of dignity, strength and beauty, which are seen imprinted on these beautiful statues.

Cit. Lalande, after remarking that the magnetic needle does not point always exactly to the pole, concludes from several observations, which he communicated to the Assembly, that it directs itself towards a certain place on the surface of the earth, which he thinks approaches very near to

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the entrance of Baffin's Bay on the northern coast of America.

Cit. Molé read, for Cit. Andrieux, a tale in verse entitled *Le Doyen de Badajoz*.

The Institute then adjudged the prize proposed the IVth year, the subject of which was "the construction of a pocket time-piece proper for determining the longitude at sea, &c."

The National Institute at Paris has applied to the Directory for permission to convoke a deputation of the *Literati* of all countries in amity with the French Republic, to establish a uniformity of weights and measures throughout the civilized world.

A Society of Agriculture and Rural Economy, which has already among its members Creuze-la-Touche, Gilbert, Thouin, Desfontaines, Dubois, Crette-Palluel, Tessier, Chabert, &c. has been established at Paris. As this society will hold public meetings, the information it must diffuse in its memoirs will no doubt tend greatly to ameliorate the state of agriculture, and to improve this useful art.

On the evening of the 17th inst. the Members of the Royal Academy of London, by desire of government, held a meeting at Somerset-house to consider of some beautiful device for our coin, which may render counterfeiting more difficult, and impress foreigners with an idea of our national taste. The idea is good so far as it goes, but it ought to go farther. Our coinage ought to be so managed as to serve for a real historical series and chronology of all important public events, whether of a prosperous or adverse nature. The Royal Society and Royal Academy would be usefully employed in producing the necessary devices, legends, &c. We say usefully, for we know of no means that could with equal facility give so much information to all ranks in the community. The events recorded on our coins should not be those only that are of a political nature: the æra of useful inven-

inventions, and the names of eminent benefactors of mankind, ought in this manner to be handed down to posterity.

ANTIQUITIES.

A DISTINGUISHED Artist, who is travelling through the southern departments of France, charged by government with a mission relative to the arts, in a letter dated Aix, Prairial 14th, says: "Some workmen, who were digging up the ground on the declivity of an eminence which overlooks Vienne, discovered a small group, consisting of two children formed of white marble, in perfect preservation, and exceedingly well executed; one of the children holds a bird, which the other endeavours to snatch from it, and which seems to peck the arm of the latter. Each of the children rests against the trunk of a tree. At the bottom of one of these trunks, and near the child which holds the bird, is seen a serpent; and on the other trunk there is a lizard having in its mouth a butterfly.

DIOPTRICKS.

THE Abbé Haüy, having polished a fragment of transparent native sulphur, found that it possesses the power of double refraction in a very eminent degree. The two faces of this fragment are inclined to each other about twelve degrees, and their greatest distance is fourteen millimetres, or a little more than six lines. If this fragment be placed on a piece of paper on which a line has been drawn, two very distinct images of the line are seen. By observing objects somewhat remote through this fragment, it may be judged, by the distance between the images, that the refraction of sulphur in itself must be very considerable, allowance being made for the density of that substance, the specific weight of which is only double that of water; and this agrees with the results of Newton, in regard to the refractive powers of inflammable bodies. Cit. Haüy proposes to make experiments in order to determine the quantity of this refraction, which

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has

has not yet been measured, and to compare it afterwards with the result of calculation, according to the proportion between the refractive powers of inflammable substances and their densities.

ARTS.

AN ingenious Artist at Paris has lately completed, with great perseverance, patience, and mathematical accuracy, a very curious model of that city, on which he has been employed nine years. He has not contented himself with comparing and correcting all the plans of Paris ever published: he measured all the streets, squares, &c. according to the most accurate geometrical methods of measurement, and determined the inequalities of the site of that immense capital by levelling. The greatest diameter of his model, in the extent from east to west, is fifteen feet. The mean size of the houses is three lines. The artist has carried his accuracy so far, that each inhabitant of Paris can distinguish his own house, court-yard, and garden. The public places and gardens are represented with a most striking similitude; and not only their dimensions but their colour and ornaments can be observed. The alternate rising and falling of the plane of the model gives to this representation a correctness which produces an effect like enchantment, if the observer supposes himself to be standing on Mount-Marte, and to be looking down on the city. The artist has with much judgment endeavoured, by the shades of his colours, to give a point of rest to the eye; the want of which is a great failing in that model of Rome which formerly stood in the library of St. Genevieve, and which now belongs to the French nation, as it exhibits the tiresome view of a dazzling white mass of gypsum. Thirty thousand trees, which distinguish the different walks, public places, and gardens, form an agreeable variety with the slated and tiled roofs. This model may be taken to pieces by means of screws, and can be packed into three large boxes for the purpose of transportation.

ENGINEERING.

A DIRECT communication between the counties of Kent and Essex has been projected by Mr. Dodd, engineer, by means which we think well calculated to answer the intended purpose. He proposes a cylindrical tunnel under the river Thames, from Gravesend to Tilbury, to be constructed wholly with key-stones, and therefore able to bear any pressure; the diameter to be sixteen feet in the clear, which Mr. Dodd imagines will be sufficient for foot, horse, and carriage-passengers; the passage to be illuminated with lamps, and a steam-engine to be erected in a proper situation to draw off the drainage water, if any should accumulate.

The expence of this stupendous undertaking is estimated at so low a sum as 15,955*l.* for 900 yards of tunnelling, relaying the bottom, lamps, lamp-irons, steam-engine, pipes, and other necessary machinery.

This projected measure will save a circuitous route of fifty miles by land (the distance from Gravesend to Tilbury, along London-Bridge). Independent of the advantage it would afford to commercial establishments and agricultural improvements, the general benefit to the counties of Kent and Essex must be immense.

Mr. Dodd is of opinion, that, whether the measure is considered as a great national improvement, or a local one to the two counties, of forming a military post of the first consequence in that part of the kingdom, for enabling troops, &c. to pass through, its importance claims the greatest attention. Another question he suggests, is, what may be the most proper method of raising the supplies to defray the expence of the undertaking—whether by the joint expence of both counties, or by a subscription of private individuals, incorporated by Parliament, with authority to levy tolls? The latter mode he is convinced would be beneficial to the individuals, and amply repay the share-holders.

The following are the estimates of the expence, as suggested by Mr. Dodd, in the first instance :

To

To 900 yards (running measure) of tunnelling, including excavations, vaulting with key-stones, &c. at 12l. per yard,	-	-	-	£10,800
To re-laying the bottom with new-made ground, 900 yards, at 1l. each,	-	-	-	900
To placing lamps and lamp-irons through the tunnel, collectors' rooms, and gates at each end,	-	-	-	400
To making good the entrance roads at each end of the tunnel,	-	-	-	160
To a steam-engine to draw off drainage-water,	-	-	-	1,780
Necessary machinery during the execution,	-	-	-	500
To ten per cent. upon the whole, for contingencies,	-	-	-	1,415
Total —				<u>£15,955</u>

VEGETATION.

IN our first number (page 109) we stated that, from some interesting experiments which had been recently made by Sir Francis Ford, it had been proved that plants sprinkled with water, previously impregnated with oxygen gas, grew much more vigorously, and displayed more beautiful tints, than those nourished with common water. The application of oxygen to promote vegetation has been since tried in the following simple manner, and the result has been the same as above stated: Bottles filled with oxygen gas, being first inverted, have had their mouths buried under ground, near the roots of the plants intended to be supplied with it. After some time the gas in the bottles was found reduced to the standard of common atmospheric air: but the oxygen had done its duty; for the plants that had been thus supplied with it were much more healthy and beautiful than others of the same kinds placed in every other respect in similar circumstances.

Erratum. Page 192, line 13, for 22d read 2d of December.

THE
PHILOSOPHICAL MAGAZINE.

AUGUST 1798.

- I. *Description of the large Orang Outang of Berneo. By F. B. VON WURMB. From the Transactions of the Batavian Society in the Island of Java.*

MANKIND have bestowed every possible pains to trace out the progress of nature, and to discover those threads by which her works are connected; and their exertions, indeed, have not always been fruitless. Thus, for example, the discovery of animal plants pointed out the transition from the vegetable to the animal kingdom. The bat and the flying squirrel displayed the connection between quadrupeds and birds; and the seal and the sea-cow that of quadrupeds with fishes.

The greatest vacuity which appears to us in the plan of nature is, certainly, that observed between man, a being endowed with reason, and the irrational animals. Naturalists hitherto have endeavoured, but in vain, by the most accurate researches to acquire some satisfaction on this point; and we may almost consider it as certain that the links of the great chain, here wanting, are not to be found in the world which we at present inhabit. Were nothing more required but similarity of bodily conformation, this transition,

tion, without doubt, would be found in the four-handed race of apes. But as the qualities of the mind are here as much considered as the form of the body, it is evident that the ape, which does not deserve the second rank among the irrational animals, cannot form the link that connects quadrupeds with man. The external figure, however, of this animal has since the earliest periods engaged the attention of naturalists; and by the similitude of its body we are led to suspect a similitude of mental powers in beings to which the all-wise Creator has given so much likeness. But as the discoveries made by the searchers into nature are frequently not so much the truth as something suited to the systems which they have adopted, this circumstance has given rise to a great deal of error. The celebrated Linnæus himself was induced by a figure which Bontius * delineated of an orang outang, or wild man, seen in the island of Java, and the accounts of some travellers, to class his *homo nocturnus* or night-man between man and the ape, and thereby to establish the existence of a being, the truth of which is as yet very doubtful.

Buffon proceeded in a much more cautious manner. That celebrated naturalist suspected, and not without reason, that the accounts given with so little accuracy of the night-men alluded only to the white negroes or kakerlaks, considered in a false light or under the veil of prejudice; and, indeed, the description given by Bontius of the orang outang differs only in some very inconsiderable circumstances from the figure of the white negro or kakerlak Saudami described by M. van Iperen†. If we take from this description of Bontius the ruff under the chin, and the few hairs which cover the head, a more beautiful human form

* Bontius resided as a physician at Batavia in the last century, and wrote *Hist. Nat. et Med. Ind. Orient.* EDIT.

† See the first part of the *Transactions of the Batavian Society in the Island of Java.*

would appear than that of Saudami *; and had the latter grown up, not at the court of the prince of Tabana, but in the solitary woods of the island of Bali, his mental powers would have been so little expanded, that an inattentive observer might have classed him among the pongos, varis, orang outangs, &c. of Battel, Pyrard, Leguat, and others. But the figure which Bontius has given us of the orang outang may have been delineated with too great a resemblance to that of man, and contrary to truth; for, if we adhere only to the description, we can discover nothing more than a common large orang outang or pongo. Briffon, who classes the orang outang of Bontius along with the vari, appears to have been of the same opinion. An instance of such a false and too human-like representation of this animal occurs also in the figure of an orang outang of the island of Borneo, given in Beckman's voyage; where the author speaks, without all doubt, of the same species as that transmitted to our society from that island. But be this as it may, it is certain that since the time Bontius resided in Java, or the middle of the last century, no orang outang, such as that delineated by him, has been found either in this island or in any of those in the neighbourhood; and as he asserts that he saw several such animals of both sexes, it is certainly incomprehensible why the least traces of them are not now to be discovered. The oldest and most experienced Javanese are acquainted with no other orang outangs than such as are real apes; and they distinguish under this Malayan name

* "The description of the white negro," says the author in his *Letters from India*, "will afford a new and incontestable proof to our naturalists, that every thing hitherto said of whole races of *kakerlaks* or white negro night-men, and the like, is mere fables, and that such men are sometimes produced here and there only by accident. The parents of this white negro, who is called Saudami, were, like the other inhabitants of their native country, the island of Bali, of a dark brown colour, and their son was not sickly, but large and strong. I found him to be five feet two inches and a half in height, Rhinlandish measure." EDIT.

two kinds without tails, which Buffon places among the pongos or jockos. Both are natives of Borneo, the only place almost where they are found; and whatever travellers may say, they are as little to be seen in the forests and wilds of Java as the lions and elephants represented on some charts of that island. The small species which Buffon, by abbreviating the Congo name, calls jocos, are often brought to Java by ships coming from Bangareï; and of this kind was that sent alive to Europe in 1776, and of which an accurate description has been given by Wosmaer. The orang outang of the large kind, or the pongo of Buffon, is not common even in its native country Borneo; and much pains and labour had been in vain employed for upwards of twenty years, in endeavouring to catch one of these strong and mischievous animals. M. Palm, the resident at Rembang, was at length so fortunate, on occasion of his being sent on an important mission to Sukkadana, to procure after a great deal of trouble one of these animals, which he sent to the Batavian Society preserved in arrack. The following accurate description of it will, in my opinion, shew how fruitless it will be to search for the wild men of Bontius in this species of orang outang.

The head in a certain degree is somewhat sharpened from behind towards the top. The mouth projects a little forwards, and on each cheek is a fleshy excrescence (*vleeschachtige kwabbe*) which extends sidewise more than the thickness of the head. The ears are small, and lie flat to the head. The eyes are small and prominent. The nose, without any perceptible elevation, consists merely of two long nostrils, placed in an oblique direction towards each other. The mouth is surrounded by thick lips, and in the inside has no pouches (*zacken*). The tongue is thick and broad. On that of the animal in question there were found some remains of green herbs which it had eaten. Each jaw is furnished before with four broad incisors, standing between two thick canine teeth, which rise above them. The face is of a dark brown colour,

colour, and has no hair, except a very thin beard. The neck is exceedingly short. The breast is much broader than the hips. At the rump there is no appearance of a tail, nor of any tough projecting hide. The penis seems to be drawn back into the body. The hands are long, and the palms as well as the fingers are of a dark brown colour, and have no hair. The legs are short and thin, but the muscles are strong. The feet have a great resemblance to the hands. The toes and fingers are furnished with black nails, almost like those of a man, except the large toes, which are smaller and shorter; a difference that arises perhaps from the frequent use made of them. The breast and the belly are mostly bare. The other parts of the body, the face, the ears, the palms of the hands, the feet and the fingers excepted, are covered with brown hair, which in many places is fully as long as the finger.

Under the skin of the throat and breast of the animal transmitted to the society, there were found two bags, one of which occupied the greater part of the breast, and, as well as the smaller which was inclosed in it, had a communication with the wind-pipe. As this rare animal was destined for the cabinet of the Prince of Orange, it was subjected to no farther anatomical researches, for fear of destroying its configuration. The bowels, to guard against corruption, were taken out before it had been transmitted to Batavia. We, however, flatter ourselves with the well-grounded hope of being able to give, at some future period, a particular and accurate account of the properties, habits and manner of living of this large orang outang, as the jurisdiction of the East India Company, under the present government, has been so considerably extended in Borneo, that access is now opened for us to the interior parts of that great island*. With regard to the manner in which this

* In the second part of the Transactions of the Batavian Society there is a pretty circumstantial description of this island, together with a short extract from the journal of the above-mentioned M. Palm.

animal was caught, we were informed' by M. Palm, that it defended itself so furiously with sharp-pointed sticks, which it broke off from the trees, that it was impossible to take it alive. This property it seems to possess in common with the African pongos, which, as Beutel says, attack elephants with these weapons, and drive them from their places of resort*.

The following is an accurate measurement of the different parts of this animal, according to the Rhinlandic foot† divided into twelve inches:

Whole length of the animal from the soles of the feet to the crown of the head 3 feet $10\frac{3}{8}$ inches. This, however, does not agree with the measurement made in the island of Borneo, where the whole length was found to be 49 inches; but perhaps a different standard was employed, or the body of the animal might have become contracted by lying in arrack. Circumference of the body at the shoulders 3 feet $\frac{5}{8}$ of an inch. Circumference of the body below the breast 3 feet $3\frac{1}{2}$ inches. Circumference at the hips 2 feet $4\frac{1}{4}$ inches. Aperture of the mouth $4\frac{1}{8}$ inches. Length or projection of the muzzle $3\frac{1}{2}$ inches. Distance from the middle of the upper lip to the eyebrows $4\frac{7}{8}$ inches. Distance between the corners of the eyes $1\frac{1}{8}$ inch. Breadth of the eye the same. Distance from the eyebrows to the hinder part of the head $6\frac{5}{8}$ inches. Diameter of the head from top to bottom $10\frac{3}{8}$ inches. Diameter of the head across, measured at the distance of $3\frac{3}{8}$ inches from the top of the above line, $6\frac{1}{2}$ inches. Diameter of the head measured as before, at the distance of $6\frac{1}{8}$ inches from the crown, $9\frac{1}{2}$ inches. External circumference of the ear $3\frac{1}{2}$ inches. Circumference of the ear below where it adheres to the head 3 inches. Height of the ear $1\frac{5}{8}$ inch. Breadth $\frac{1}{4}$ of an inch. Distance from

* Ought not this property to procure to the orang outang the first rank among animals next to man? For, whatever Buffon may say to the contrary, we know of no other animal which willingly employs for its defence any weapons but those bestowed on it by nature.

† The Rhinlandish is to the English foot as 1033 to 1000. It is therefore equal to 12.396 English inches. EDIT.

the share bone to the collar bone 2 feet $\frac{1}{4}$ of an inch. Distance of the breast bone from the share bone 1 foot $\frac{7}{8}$ of an inch. Distance between the nipples of the breast $9\frac{3}{4}$ inches. Length of the arms to the tips of the fingers 3 feet $\frac{1}{2}$ of an inch. Circumference of the arm at the shoulder $11\frac{1}{8}$ inches; in the middle 1 foot $\frac{3}{8}$ of an inch; at the elbow 11 inches. Circumference of the fore part of the arm in the middle $10\frac{7}{8}$ inches; at the hand $8\frac{1}{4}$ inches. Length of the upper part of the arm 1 foot $\frac{1}{4}$ of an inch. Length of the lower part of the arm 1 foot $2\frac{1}{4}$ inches. Length of the hand from the joint to the tip of the middle finger $9\frac{3}{4}$ inches. Length of the thumb 3 inches; of the second finger $4\frac{1}{4}$ inches; of the middle finger $5\frac{3}{8}$ inches; of the fourth finger $5\frac{1}{8}$ inches; of the little finger $4\frac{1}{8}$ inches. Circumference of the hand measured at the root of the thumb $9\frac{5}{8}$ inches; of the thumb and the three following fingers $3\frac{5}{8}$ inches; of the fifth finger $3\frac{1}{8}$ inches. Length of the palm of the hand $5\frac{1}{2}$ inches. Breadth of the palm of the hand $4\frac{1}{4}$ inches. Thickness of the hand $1\frac{1}{8}$ inch. Length from the heel to the upper end of the thigh bone 1 foot $8\frac{3}{8}$ inches. Length of the thigh bone 1 foot $5\frac{1}{4}$ inches. Circumference of the thigh 1 foot $5\frac{1}{4}$ inches. Length of the leg from the knee to the sole of the foot $11\frac{1}{8}$ inches. Circumference of the leg close under the knee 11 inches; at the middle of the leg $10\frac{5}{8}$ inches; at the ankle 10 inches. Circumference of the foot where the large toe begins $10\frac{3}{4}$ inches. Length of the great toe $2\frac{1}{2}$ inches; of the second toe $4\frac{3}{8}$ inches; of the third toe 5 inches; of the fourth toe $4\frac{1}{4}$ inches; of the fifth toe $4\frac{1}{2}$ inches. Breadth of the sole of the foot where the great toe begins 4 inches. Breadth of the sole of the foot at the heel 3 inches. Length of the sole from the heel to the beginning of the toes $6\frac{5}{8}$ inches. Circumference of the great toe 4 inches; of the three following toes $3\frac{1}{2}$ inches; of the fifth toe $3\frac{3}{8}$ inches. Width between the root of the great toe and the root of the second toe 4 inches.

II. *Observations on a singular Phenomenon called the Spectre of the Broken.* By J. L. JORDAN. From Gottingisches Journal der Naturwissenschaften, by J. F. GMELIN. Vol. I. Part III. 1798.

In the course of my repeated tours through the Harz*, I ascended the Broken twelve different times; but I had the good fortune only twice (both times about Whitsuntide) to see that atmospheric phenomenon called the Spectre of the Broken, which appears to me worthy of particular attention, as it must, no doubt, be observed on other high mountains which have a situation favourable for producing it.

The first time I was deceived by this extraordinary phenomenon I had clambered up to the summit of the Broken, very early in the morning, in order to wait there for the inexpressibly beautiful view of the sun rising in the east. The heavens were already streaked with red; the sun was just appearing above the horizon in full majesty, and the most perfect serenity prevailed throughout the surrounding country, when the other Harz mountains in the south-west, towards the Worm mountains, &c. lying under the Broken, began to be covered by thick clouds. Ascending at that moment the granite rocks called the Teufelskanzel, there appeared before me, though at a great distance, towards the Worm mountains and the Achtermannshöhe, the gigantic figure of a man, as if standing on a large pedestal. But scarcely had I discovered it when it began to disappear; the clouds sunk down speedily and expanded, and I saw the phenomenon no more.

The second time, however, I saw this spectre somewhat more distinctly, a little below the summit of the Broken, and near the Heinrichshöhe, as I was looking at the sun rising about four o'clock in the morning. The weather was rather tempestuous; the sky towards the level country was

* The Harz mountains are situated in Hanover.

pretty clear, but the Harz mountains had attracted several thick clouds, which had been hovering around them, and which beginning to settle on the Broken confined the prospect. In these clouds, soon after the rising of the sun, I saw my own shadow, of a monstrous size, move itself for a couple of seconds exactly as I moved; but I was soon involved in clouds, and the phenomenon disappeared.

It is impossible to see this phenomenon, except when the sun is at such an altitude as to throw his rays upon the body in a horizontal direction; for, if he is higher, the shadow is thrown rather under the body than before it.

In the month of September last year, as I was making a tour through the Harz with a very agreeable party, and ascended the Broken, I found an excellent account and explanation of this phenomenon, as seen by M. Haue on the 23^d of May 1797, in his diary of an excursion to that mountain. I shall therefore take the liberty of transcribing it. "After having been here for the thirtieth time," says M. Haue, "and, besides other objects of my attention, having procured information respecting the above-mentioned atmospheric phenomenon, I was at length so fortunate as to have the pleasure of seeing it; and perhaps my description may afford satisfaction to others who visit the Broken through curiosity. The sun rose about four o'clock, and, the atmosphere being quite serene towards the east, his rays could pass without any obstruction over the Heinrichshöhe. In the south-west, however, towards Achtermannshöhe, a brisk west wind carried before it thin transparent vapours, which were not yet condensed into thick heavy clouds.

"About a quarter past four I went towards the inn, and looked round to see whether the atmosphere would permit me to have a free prospect to the south-west; when I observed, at a very great distance towards Achtermannshöhe, a human figure of a monstrous size. A violent gust of wind having almost carried away my hat, I clapped my hand to it
by

by moving my arm towards my head, and the colossal figure did the same.

“The pleasure which I felt on this discovery can hardly be described; for I had already walked many a weary step in the hopes of seeing this shadowy image, without being able to gratify my curiosity. I immediately made another movement by bending my body, and the colossal figure before me repeated it. I was desirous of doing the same thing once more—but my colossus had vanished. I remained in the same position, waiting to see whether it would return, and in a few minutes it again made its appearance on the Achtermannshöhe. I paid my respects to it a second time, and it did the same to me. I then called the landlord of the Broken; and having both taken the same position which I had taken alone, we looked towards the Achtermannshöhe, but saw nothing. We had not, however, stood long, when two such colossal figures were formed over the above eminence, which repeated our compliments by bending their bodies as we did; after which they vanished. We retained our position; kept our eyes fixed on the same spot, and in a little the two figures again stood before us, and were joined by a third. Every movement that we made by bending our bodies these figures imitated—but with this difference, that the phenomenon was sometimes weak and faint, sometimes strong and well defined. Having thus had an opportunity of discovering the whole secret of this phenomenon, I can give the following information to such of my readers as may be desirous of seeing it themselves. When the rising sun, and according to analogy the case will be the same at the setting sun, throws his rays over the Broken upon the body of a man standing opposite to fine light clouds floating around or hovering past him, he needs only fix his eyes stedfastly upon them, and, in all probability, he will see the singular spectacle of his own shadow extending to the length of five or six hundred feet, at the distance of about two miles

miles before him. This is one of the most agreeable phenomena I ever had an opportunity of remarking on the great observatory of Germany."

III. *An Account of Mr. PARK's Journey into the Interior Parts of Africa. From the Proceedings of the African Association, 1798.*

[Concluded from Page 204.]

THE city of Sego, at which Mr. Park had now arrived, consisted of four divisions or quarters, two on each side of the water; and each of them being surrounded by a mud wall, it had the appearance of four distinct towns. The houses are built of clay, and have flat roofs; but some of them have two stories, and many are white-washed. Besides these buildings, Moorish mosques are seen in every quarter. These objects, with the numerous boats on the river, a crowded population, and the cultivated state of the surrounding country, formed altogether a prospect of civilisation and magnificence which our traveller little expected to find in the bosom of Africa. From the best inquiries he could make, he had reason to believe that the place contained altogether about 30,000 inhabitants.

The boats on the Niger are formed of the trunks of two large trees rendered concave, and joined together, not side by side, but lengthways, the junction being exactly across the middle of the boat. They are therefore very long, and disproportionably narrow; and have neither decks nor masts: they are however roomy. Mr. Park observed in one of them four horses and a great many people crossing at a ferry.

To this ferry Mr. Park proceeded, intending to cross over to the largest quarter of the city, where he was informed the king of Bambara held his residence; but the number of people pressing for a passage was such as to prevent his embarkation.

The multitude gazed on the stranger with silent wonder ; and he distinguished with concern many Moors among them. In the mean time, information that a white man was waiting for a passage was conveyed to the king ; who immediately sent a messenger to inquire what brought him to Sego, and what he wanted ? Our traveller, having given the best answer he could as to the motives of his journey, added, that he was there in his way to Jenné, and, having been robbed of all he possessed, implored the king's bounty and protection. The messenger told him to go to a distant village, which he pointed out, and wait for the king's farther orders.

Mr. Park complied with these directions, but found that the inhabitants of the village were either averse or afraid to give him lodging or entertainment ; and having turned his horse loose, he sought shelter from a storm of thunder and rain under a tree. At length, as night approached, the kindness and humanity inherent in the female sex, to which he had often been indebted on former occasions, came to his relief on the present. A poor negro woman returning from the labours of the field observed that he was wet, weary and dejected, and, taking up his saddle and bridle, told him to follow her. She led him to her cottage, lighted up a lamp, procured him an excellent supper of fish, and plenty of corn for his horse ; after which, she spread a mat upon the floor, and said he might remain there for the night. For this well-timed bounty our traveller presented her with two of the four brass buttons which remained on his waistcoat. Mr. Park relates that this good woman, having performed the rites of hospitality herself, called in the female part of her family, and made them spin cotton for a great part of the night. They lightened their labour by songs : one of which must have been composed extempore ; for our traveller was himself the subject of it ; and the air was, in his opinion, the sweetest and most plaintive he had ever heard. The words, as may be expected, were simple, and may be literally translated as follows : “ The winds roared, and

and the rain fell. The poor white man, faint and weary, came and sat under our tree. He has no mother to bring him milk—no wife to grind his corn.”——*Chorus*. “Let us pity the white man; no mother has he, &c. &c.”

Mr. Park continued all the next day in the village, without receiving any orders from the king, and found himself the object of universal inquiry. He soon heard enough, however, to convince him, that the Moors and Slatees or slave traders, residing in Sego, were exceedingly suspicious concerning the motives of his journey, and in the highest degree hostile towards him. He learnt that many consultations had been held with the king concerning his reception and disposal; and the villagers openly told him that he had many enemies, and must expect no favour.

On the third day the messenger arrived; and, bringing a bag in his hands, signified to our traveller that he must depart forthwith from the vicinage of Sego; but that Mansong the king, wishing to relieve a white man in distress, had sent him 5000 kowries* to enable him to purchase provisions in the course of his journey. The messenger added, that if Park's intentions were really to proceed to Jenné, he had orders to accompany him as a guide to Sanfanding.

Being thus compelled to leave Sego, Mr. Park applied himself to collect all the information he could from his guide. Though it was evident that this man was sent principally in the view of discovering the motives and object of his journey, he was found to be very friendly and communicative. By him Mr. Park was frankly told, that if Jenné was the place of his destination, he had undertaken an enterprise of greater danger than probably he was apprised of; for, although the town of Jenné was nominally a part of the king of Bambara's dominions, it was in fact a city of

* Kowries or cowries are small shells which in Africa and many parts of the East Indies pass current as money. In Bambara a hundred of them would purchase a day's provision for a traveller, and corn for his horse.

the Moors; the principal part of the inhabitants being Bushreens or Mahometans; and even the governor himself, though appointed by Mansong, was of the same sect. Mr. Park's reflections on this occasion were aggravated by the circumstance, that his danger was likely to increase as he advanced on his journey; for he learnt that the places beyond Jenné were under the Moorish influence, in a still greater degree than Jenné itself; and that Tombuctoo, the great object of his research, was altogether in the possession of that savage and merciless people.

Notwithstanding these discouraging reflections, Mr. Park persisted in what he conceived to be his duty; and the first town of note at which he arrived after leaving Sego, was called Kabba. It is situated in the midst of a beautiful and highly cultivated country, "bearing," says Mr. Park, "a greater resemblance to the centre of England, than to what I should have supposed had been in the middle of Africa;" and the season was that of the *shea* harvest, or the gathering in the fruit which produces the *shea-toulou* or tree-butter, the great abundance of which in this quarter was astonishing. The tree itself very much resembles the American oak; and the nut, from the kernel of which the butter is prepared by boiling it in water, has somewhat the appearance of a Spanish olive. The kernel is enveloped in a sweet pulp under a thin green rind; and it is Mr. Park's opinion, that the butter produced from it, besides the advantage of its keeping without salt the whole year, is whiter, firmer, and of a richer flavour than the best butter he ever tasted made from cow's milk. The growth and preparation of this commodity seem to be among the first objects of African industry in this and the neighbouring states; and it constitutes a main article of their inland commerce.

On the afternoon of the second day Mr. Park and his guide reached Sanfanding, a very large town situated on the banks of the Niger, much resorted to by the Moors, who bring thither large quantities of salt, which they barter for

shea

shea toulou and gold dust. Leaving this place early next morning, he proceeded to a town called Nyara, and from thence to Modibao, a delightful place on the banks of the river, which is here very broad, and enlivened with many small and verdant islands, all of them stocked with cattle and crowded with villages. Here he was compelled to set off again abruptly, for fear of the Moors, the *dooty* or chief man giving him a guide to Kea; but his horse, which had been long reduced to a mere skeleton, dropped on the road, and he was obliged to quit him. At Kea he embarked in a fishing canoe, and was landed in six hours at Silla, a large town on the southern side of the Niger. At this place the *dooty* was nearly as savage as the Moors, and it was with great difficulty our traveller could get shelter for the night. He was now convinced by painful experience, that the obstacles to his farther progress were insurmountable, and that in attempting to reach Jenné, unless under the protection of some men of weight and influence among the Moors, which he had no possible means of obtaining, he should sacrifice himself to no purpose; for his discoveries would perish with him. He considered at the same time, that by returning to Gambia in a different route, he might still promote in some degree the purpose of his mission; for, having discovered the Niger at a great distance from its head, he should be adding considerably to the geography of Africa, in tracing this mysterious river up the stream to its source. On these and similar considerations Mr. Park determined to return to Sego, and, proceeding from thence along the banks of the river, trust for his support to the hospitality of the negroes in the southern states, out of the reach of Moorish fanaticism and malice.

The town of Silla, from which Mr. Park began his return homewards, is within two short days journey of Jenné, which is situated on an island in the river. At the distance of two days more the river empties itself into a considerable lake, called Dibbie or the Dark Lake; concerning the extent

of

of which, all the information which could be obtained was, that in crossing over it from west to east the canoes lose sight of land one whole day. From this lake the water issues in many streams, which terminate in two large branches. One of these flows towards the north-east, and the other to the east; but they join again at Kabra, one day's journey to the southward of Tombuctoo, and the port or shipping-place of that city. The tract of land which the two streams encircle is called Jinbala, and is inhabited by negroes; and the whole distance by land from Jenné to Tombuctoo is twelve days journey. From Kabra, at the distance of eleven days journey down the stream, the river passes to the southward of Houssa, which is two days journey distant from the river. Of the further progress of this great river, and its final exit, whether it be the same that passes by Kaffina*, or whether, as ancient charts seem to indicate, it spreads into one or more inland lakes, or at an immense distance intermixes with the waters of the Nile, are questions which future discovery can alone resolve.

On the third day of August Mr. Park left Silla, intending to return through Sego in his way back to Gambia; and at Modibao he had the good fortune to recover his horse, which he found somewhat improved in condition. Here he learnt that Mansong, having been persuaded by the Moors that our traveller had come into his country with some mischievous intention, had given orders to apprehend him. He therefore thought it prudent to avoid Sego altogether; which he accordingly did, by taking a circuitous route until he had got considerably to the west; when turning towards the Niger, he passed through many towns and villages on its banks; the largest of which, called Sammee, he left on the 14th of August, and lodged that night at Benni. On the morning of the 16th he arrived at Jabbee, a large town with a Moorish mosque in it. The same day

* Erroneously spelt *Casbna*.

he passed through Yamina, and on the 20th reached Kooli-korro, a great salt-market. On the following day he proceeded to Marraboo, and in two days more arrived at Bam-makoo, the frontier of the kingdom of Bambara.

During the course of this peregrination through the king of Bambara's dominions, our traveller had to encounter the tropical rains in all their violence; and he was principally indebted for his daily support to the dooty or chief man in the several towns through which he passed. This officer seems to possess in some respects the authority of mayor in the corporate towns of England; and it reflects great honour on the police of the African kingdoms, or on the benevolent manners of the natives, that it is considered one part of the dooty's obligation to provide food for the necessitous traveller:—*To suffer the king's stranger to depart hungry*, such is the phrase used, is an offence of a very heinous nature. On many occasions Mr. Park offered payment, for what he received, out of the kowries that still remained of the king's present, and his offer was sometimes accepted, and sometimes refused. On others he remunerated his host in a singular manner, the particulars of which deserve to be recited. Among the various impostures practised by the Moors towards the poor negroes, they frequently sell them scraps of paper with an Arabic inscription (commonly a passage from the Koran), which are called *saphies* or charms. With one of these about his person, the possessor considers himself invulnerable, and neither the lurking serpent nor the prowling leopard is any longer the object of his dread. In the circumstances to which Mr. Park was reduced, he had the good fortune to discover that the negro natives ascribed to him the power of granting saphies of even more than Arabian virtue. "If a Moor's saphie is good," said the dooty of Sanfanding, "a white man's must be better;" and Mr. Park, at his request, gave him one possessed of all the virtues he could concentrate, for it contained the Lord's Prayer. The pen with which it was written was made of a

reed ; a little charcoal and gum-water made very tolerable ink, and a thin board answered the purpose of paper. In his journey westward this merchandize turned to extraordinary good account ; and it is surely needless for Mr. Park to frame any apology for having availed himself of such a resource in his situation.

At Bammakoo the Niger ceases to be navigable. It takes its rise at a small village called Sankari in the high lands of Jallonkondoo, about six days journey S. W. from Bammakoo ; and the country becoming mountainous, our traveller on the 22d took the path for Sibidooloo, where he arrived at the end of two days. On the 30th he came to Wonda, a fine village regularly built and surrounded by a wall. Here he was confined several days by sickness ; and having nothing else to offer to the friendly negro, in whose house he was accommodated, Mr. Park presented him, at parting, with his horse, now indeed become unable to proceed any farther. On the 8th of September he set out on foot for Kinneyeto, a considerable town, which he reached on the 11th, and in three days more arrived at Kamalia. At this place Mr. Park, worn down by fatigue and the vicissitudes of the weather, having sometimes been plunged up to the neck in rivers and swamps, and sometimes lost in woods and deserts, without shelter, clothing, or food, fell into a severe and dangerous fit of sickness, in which the remembrance of past suffering, and the hopes of future enjoyment, had nearly been extinguished together. On his arrival at Kamalia he had still a space of 500 miles to traverse before he could reach any friendly country on the Gambia ; and being informed that great part of the way lay through a desert, which it was impossible he could cross singly and unsupported, he had no other resource but to wait for the first caravan of slaves that might travel the same track. Such a one was expected to pass through Kamalia at the end of three months, and the chief director of it resided in that place. To him, therefore, Mr. Park applied ; and for the value of one slave,

to be paid on his safe arrival at the Gambia, this worthy negro, whose name was Karfa Taura, not only undertook to conduct him safe to Pisania, but offered him likewise the accommodation of his house until the time of the caravan's departure. Under this man's roof our traveller was confined to a mat, which was his only bed, by a severe and dangerous fever for upwards of a month. Five months longer he was detained for the caravan. During this long interval not a murmur escaped the lips of Karfa, or of any of his wives, at the trouble and expence which their inmate brought upon them. To the kind attentions, the tender solicitude, the cheerful assiduity, and warm hospitality of these poor Pagans, Mr. Park declares he is indebted not only for his safe return to Great Britain, but also for the preservation of his life; and he admits that he made his friend Karfa but an inadequate return, though the best in his power, by presenting him, on their arrival at Gambia, with double the sum that he had originally promised.

The whole of Mr. Park's route, both in going and returning, having been confined to a tract of country bounded nearly by the 12th and 15th parallels of latitude, it must be imagined that he found the climate in all places exceedingly hot. On the borders of the desert, where the fierceness of the tropical sun is reflected from the sands, the heat was scarcely supportable. Having been robbed of his thermometer, he had no means of forming a comparative judgment; but he well remembers that in the dry season, when the wind blows from the east and north-east across the desert, the ground became so hot in the middle of the day as not to be borne by the naked foot. In the camp at Benowm even the negro slaves, accustomed as they were to this temperature, could not walk from one tent to another without their sandals. At this time of the day the Moors lie stretched at length in their tents, either asleep or unwilling to move; and Mr. Park declares, that, as he lay listlessly along after their manner in his hut of reeds, he could not hold his hand

against the current of air which came through the crevices, without suffering very sensible pain from its scorching effect. In the southern districts, which abound with wood and water, the climate improves; and in the mornings and evenings the air is serene, temperate and pleasant. During the rainy season the prevailing wind is from the south-west. The monsoon commonly changes about the latter end of June, and the wind continues to blow from the south-west quarter until the middle or end of October. In this interval the country is flooded, and the rains are preceded and followed by dreadful tornadoes or typhons. The commencement of this monsoon is the spring or seed-time, and its termination is commonly the season of harvest.

Among the principal productions of the negroe territories is the *lotus*. It is rather a thorny shrub than a tree, and abounds in all the countries which Mr. Park traversed; but it thrives best in a sandy soil. Its fruit is a small yellow farinaceous berry, about the size of an olive, which being pounded in a wooden vessel, and afterwards dried in the sun, is made into excellent cakes resembling in colour and flavour the sweetest gingerbread. Some of the natives prepare from it also a liquor deliciously sweet.

Of one species of their corn the negroes make excellent beer, by malting the seeds nearly in the same manner as barley is malted in England; and the beer which is thus made was to Mr. Park's taste equal to the best strong beer he had ever drank in his native country.

In the latter end of April 1797 the *ceffle* or caravan being at length completed, and our traveller's health re-established, he set out from Kamalia in company with seventy persons, of whom only thirty-seven were slaves for sale. In nine days they came to Maana, bordering on a branch of the Senegal. In ten days more they reached the small but fertile state of Dentilla, and crossed in their journey some of the streams that contribute to the great river of Gambia. On the 4th of June they fell in with that river, about two days journey
above

above the falls of Baraconda, to which place it is navigable for canoes from its mouth; and in six days more, on the 10th of June, Mr. Park, to his infinite satisfaction, having undergone in his journey, from the heat of the weather, from fatigue, and from hunger, more than he could find words to describe, entered the hospitable mansion of Dr. Laidley, from which he had set out eighteen months before.

On the 15th of the same month he embarked in a slave ship bound to America; which being driven by stress of weather to Antigua, Mr. Park took his passage from thence in a vessel bound to Great Britain; and on the 25th of December last arrived safely in London.

IV. *Explanation of the French Measures and Weights, pointing out their Value and principal Uses, according to the Law of Germinal 18th, 3d Year of the Republic. From the Journal de Physique, 1798.*

MEASURES OF LENGTH.

CENTIMETRE. The hundredth part of the metre. This is rather a subdivision than a particular measure*.

Decimetre. Tenth part of the metre. The double decimetre makes a very convenient measure for the pocket.

METRE. The standard of the measures of the republic being the ten-millionth part of a quarter of the meridian, or the length of about 3 feet $11\frac{4}{100}$ lines; it may serve for measuring cloth, stuffs, &c. It makes about the ordinary height of a walking-stick, which any person may carry in the hand. The demi-metre and the double metre may be useful for different kinds of measurement.

Decametre. Ten times the length of the metre. About thirty feet ten inches. Proper to form a chain for land-surveying.

* The millimetre, or the thousandth part of the metre, might be here mentioned; but it is of little use in commerce.

Hectometre. Length of a hundred metres. Will not be used.

Kilometre. Equal to a thousand metres, or about 580 toises. Four will make about a common league.

Myriametre. Its value is ten thousand metres, or about 5800 toises, which is a little more than one stage. The kilometre and the myriametre will be convenient to express distances in itineraries, and to regulate boundaries in order to measure the highways.

MEASURES OF CAPACITY.

Centilitre. There is no need for a smaller measure of this kind. It may be considered as equal to a small glass for spirits and liquors. The double of it would serve extremely well for the same purpose.

Decilitre. This is almost equivalent to a common goblet. The use of it may be readily conceived. Its half and its double are analogous to other measures now employed for liquids.

LITRE. Its content is equal to a cubic decimetre. It differs very little from the *litron*, and the Paris pint; and may be employed in the same manner, either for liquids or dry substances. Its half and its double will be also very useful.

Decalitre. It may be substituted, as well as the double decalitre, for measuring corn and all sorts of grain.

The *demi-decalitre* may supply the place of the *picotin* (peck).

Hectolitre will serve for various dry substances, such as grain, salt, plaster, lime, coals, &c. The content of this measure might be given to casks for wine. The *demi-hectolitre* will be also exceedingly useful, and particularly for grain.

Kilolitre. Equal in content to a cubic metre. It is equivalent almost to the ton used in shipping, which is
not

not so much an instrument of measurement as a mode of valuation.

The *myrialitre* is superfluous*.

WEIGHTS.

The *milligramme* would weigh a little less than $\frac{1}{51}$ of a grain, consequently would give much more exactness than the 32ds which have been used hitherto; but as this measure is employed only in very nice operations, which do not occur in the common usages of commerce, weights may be confined to the following:

Centigramme. The hundredth part of a gramme, or about $\frac{1}{5}$ of a grain.

Decigramme weighs a little less than two grains. The demi-decigramme is almost equal then to the common grain.

GRAMME. Equivalent to the weight of a cubic centimetre of water, which makes about nineteen grains. Very analogous to the *gramma* of the Greeks, from which it takes its name. It is exceedingly proper to serve as unity in weighing valuable articles, such as gold and silver, and all those which require a great deal of accuracy.

Decagramme. The weight of ten grammes. Its half makes about a *gros* (a dram) and a third. Its double is a little less than two thirds of an ounce.

Hectogramme. The weight of a hundred grammes.

Kilogramme. The weight of a thousand grammes, very convenient to be used in the sale of the most common articles. Its half exceeds our usual pound by about three *gros*.

Myriagramme. The weight of ten thousand grammes, a little less than $20\frac{1}{2}$ pounds. Its double will form the largest

* If the series of decimal litres increased by the doubles and halves of each be compared with the ancient measures, it will be seen that, from the *centilitre* to the *decalitre*, they agree perfectly for liquids; and from the *demilitre* to the *hectolitre*, for the various dry articles:

weight necessary to be employed, and will answer with great advantage for that purpose*.

AGRARIAN MEASURES.

Centiare. Deciare. The centiare and deciare are only subdivisions of the *are*. The first is equal to a square metre. The second is equal to ten.

ARE. The unity of measures for land or surveying. It is equivalent to a square decametre, or a hundred square metres (about 25 square toises). It is well suited for the measurement of the valuable ground in cities, gardens, and small possessions, or such as are of a moderate extent. The denomination of *deca-are*, or *decare* by shortening it, will scarcely be of any use.

Hectare. This is a superficies containing a hundred ares. It may be employed for measuring lands of a certain extent. The hectare is somewhat less than double the large acre of 100 square perches, the perch being 22 feet.

The *kilare* is of no importance.

Myriare. Equal to ten thousand ares, or a square the side of which is a kilometre. It is consequently proper for the measurement of lands of little value, such as commons, &c. when it is not necessary to express them in squares of long measure.

MEASURES FOR FIRE WOOD.

STERE. A quantity equal to a cubic metre. By giving the length of a metre to billets, nothing more will be necessary, in order to obtain the stère, than to range them within

* The utility of the doubles and halves of each of the weights, which compose the decimal series, may be readily conceived. By forming of the whole one series, it will be seen that it is extremely analogous to that of the ancient weights, for which it may be substituted with great advantage in all commercial transactions.

a square frame (*chaffis*), each side of which is equal to a metre. If the billets have another length, for example $3\frac{1}{2}$ feet, as required by the ordinance respecting waters and forests, a small change only will be required in the height of the frame; and this will be attended with no difficulty.

The stère will be very convenient. It will be about half the *demi-voie* * of wood at Paris.

The *demi-stère* and the double stère may also be employed. Lastly, the *deci-stère*, or rather the double *deci-stère*, may be used likewise to regulate the size of faggots, and the measure of smaller pieces of wood (*cottrels*), by determining their proper length.

The other combinations of the stère do not seem to present any utility of consequence.

MONEY.

The different divisions of money are considered here as imaginary coins, without paying any regard to the proper value of the principal unity.

Centime. The hundredth part, or value of the hundredth part of a franc.

Decime. Tenth of a franc, equal to two sous.

FRANC. Principal unity of the French money, or the same as the livre of 20 sous. Its absolute value, that is to say, the quantity which it will purchase of a certain sort of merchandise, varies, as is well known, according to circumstances.

* A *voie* is equal to half a cord, the cord being eight feet in length and four in height. The *demi-voie* then is equal to a quarter of a cord. EDIT.

V. *Account of Dr. PERKINS's Discovery of the Influence of Metallic Tractors, in removing many of the Diseases of the Human Body.*

THIS discovery has made some noise in America, and, like every novelty, has its advocates and its opponents. The son of the inventor, now in London, has published a small work on the subject, to introduce it to the notice of medical men in this country, from which we extract the following particulars.:

Galvani, the celebrated professor at Bologna, was the first who announced some curious phenomena, observed from an accidental application of metallic substances to the nerves and muscles of animals. The subject immediately engaged the attention of philosophers throughout Europe, and the public, in consequence, were soon favoured with a confirmation of Galvani's assertions, by the publication of the experiments of Valli, Volta, Fowler, Monro, Cavallo, &c. The result of these various researches proved that "the influence is not peculiar to a few animals only, but seems to be a property of all." Although the living animal is most susceptible of the influence, yet, from a combination of different metals, the nerves and muscular fibres, long after every appearance of vitality was removed, have been excited to powerful action.

From the discovery of a new law *, acting so important a part in the animal œconomy, it might rationally be expected that attempts would be made to ascertain how far this principle could be applied in a remedial point of view to human diseases. This has been the particular enquiry of Doctor Perkins.

* The term ANIMAL ELECTRICITY, which arose from the many analogies that were observed between the influence discovered by Galvani and electricity, has by later writers given place to GALVANISM, a compliment well merited by the ingenious discoverer.

Several phenomena relating to the influence of metals in cases of pains, he had observed before the news of Galvani's discovery had reached America; and when the physiologists of Europe were engaged in experimenting on the denuded nerves and muscles of the smaller animals, with a view to ascertain the agency of this incomprehensible property in them, Dr. Perkins was prosecuting a series of experiments, which consisted in applying externally, to parts affected with disease, metals and compounds of metals, of every description, which occurred to him, and constructed into various forms and sizes. The result proved, that on drawing lightly over the parts affected certain instruments, termed **TRACTORS**, which he formed from metallic substances into pointed shapes, he could remove most of those topical diseases of the human body, where an extra degree of nervous energy or vital heat was present; unless such disease was situated in some of the internal viscera, too remote from the part where the instruments could be applied. The diseases which have been found most susceptible of the influence of the tractors, are rheumatism, some gouty affections, pleurisy, ophthalmias, erysipelas, violent spasmodic convulsions, as epileptic fits and the locked jaw, the pain and swelling attending contusions, inflammatory tumors, the pains from a recent sprain, the painful effects of a burn or scald, pains in the head, teeth, and indeed most kinds of painful topical affections, excepting where the organic structure of the part is destroyed, as in wounds, ulcers, &c. and excepting also where oils or some other non-conducting substances are present.

This practice, like all considerable innovations, on its first introduction, encountered the severest scepticism and ridicule, and a medical society pronounced it a revival of the exploded practice of animal magnetism: but the president and many of the members of that society afterwards applied the tractors to practice, and have since published the success of their numerous experiments.

As most phenomena are learned from observation long before we arrive at the theory which connects and explains them, so with this metallic influence, no clear and satisfactory explanation of the *modus operandi* has yet appeared.

Notwithstanding the assiduity with which physiologists have pursued their enquiry, and are still pursuing*, to discover the laws and properties of Galvanism, and to ascertain the extent of its action in the animal œconomy; yet, like many other phenomena, they still remain mysteries.

Mr. Meigs, professor of natural philosophy at Newhaven, in a letter on Dr. Perkins's discovery, conceives the principles of metallic irritability so little understood, that he will not pretend to explain *how* the tractors produce their effects; but seems satisfied in finding that the effects are produced. After stating an experiment on his own child, eight years of age, very dangerously ill with a peripneumonic complaint, and to which the tractors gave almost instantaneous relief, he says, "I have used the tractors with success in several other cases in my own family; and although, like Naaman the Syrian, I cannot tell why the waters of Jordan should be better than Abana and Pharpar, rivers of Damascus; yet, since *experience* has proved them so, no reasoning can change the opinion. Indeed, the causes of all common facts are, *we think*, perfectly well known to us; and it is very probable, fifty or an hundred years hence, we shall as well know why

* The celebrated Von Humboldt of Germany has lately published a volume of 500 pages 8vo. and is now preparing another. These consist of numerous experiments, chiefly on the nerves and muscular fibre; and from the success with which his enquiries have already been attended, great hopes are entertained that something important will result. M. Creve, professor of medicine at Mentz, has lately published an important tract on Metallic Irritability. He maintains, from a variety of experiments made on the dead bodies of men and animals, that even the symptoms of putrefaction do not constitute an *infallible* evidence of death, but that the application of metals will in all cases ascertain it beyond the possibility of mistake. This discovery is of great importance, as it may be applied to prevent the dreadful error of premature inhumation.

the

the metallic tractors should in a few minutes remove violent pains, as we now know why cantharides and opium will produce opposite effects: viz. we shall know but *very little* about either, excepting *facts*."

Mr. Woodward, professor of natural philosophy at Dartmouth, in a letter also on the same subject, has stated a number of successful experiments in pains of the head, face, teeth, and in one case of a sprain.

Dr. Vaughan, a member of the Philadelphia medical society, has lately published an ingenious tract on Galvanism, the object of which is to account for the influence of the tractors in removing diseases. After a citation of numerous experiments made on the nerves and muscles of animals, he observes, "If we only take an impartial view of the operations of nature herself, and attend diligently to the analytical investigations of the aforementioned experimentalists on this sublime subject, I think the sceptic must admit that the principle of nervous energy is a modification of electricity. As sensation is dependent on this energy, a pleasurable sensation, or what may be termed a natural or healthy degree thereof, then certainly pain or supersensation can only depend on an accumulation of the electric fluid, or extra degree of energy in the part affected. On this principle the problem admits of easy solution; namely, that the metals, being susceptible of this fluid, conduct the extra degree of energy to parts where it is diminished, or out of the system altogether, restoring the native law of electric equilibrium."

Drs. Tilton, Baker, Hall, Lord, Brewster, Dalho, Dyer, Johnson, Backus, Lee, Willard, Marvin and Gofs, of America, have published their approbations of the use of metallic tractors; which are in fact only pieces of pointed iron or brass, &c. How far the attempt of the author to explain their action upon the principles of Galvanism has been successful, we will not take upon us to determine. We shall only observe, that were it even demonstrated to be a revival of animal magnetism, *if its efficacy be at the same time de-*

monstrated, it will not be therefore rejected; for in that case it would only be a proof that the empiricism of the practisers of magnetism, by introducing absurd glare, show and mystery, had been the means of obscuring the principles on which it was founded. We are led to make this remark by an observation of the author, "That in some instances the metallic influence, *when excited by different persons*, produces *different effects*." Experiments made to ascertain the point, proved that there were persons who might use the tractors for any length of time, in diseases which were suitable for the operation, and *produce no perceptible effect*; when by placing them in the hands of another person, who should perform the operation precisely in the same manner as before, *the pain or inflammation would be removed directly*." A note introduced here by the author, to prove by this fact the analogy between the influence of the tractors and Galvanism, does not appear, to us, to be in point. "On the application of zinc and silver to the tongue, the sensation of taste is very slight to some, while with others it is very strong:—when the experiment is applied to the sense of sight, some are hardly sensible of it, while others observe a strong flash." Here, however, the cause of the different effects produced must be sought for in the modification, or peculiar structure, of the organs of sensation *in the patient*—not in *the operator*.

We mean not by this observation to detract from the merit of the discovery: that must rest, independent of all theory, on the degree of evidence that may be brought forward to support it. If the facts shall be sufficiently conclusive to establish the efficacy of the tractors, in removing only *one species of disease*, the inventor has nothing to fear from the opposition of the faculty in England:—the gentlemen who compose that body are too liberal to oppose any beneficial innovation, merely because it comes from a foreigner. On the other hand, if the cures reported to have been performed in America cannot be effected here by the same means, and in cases in which there can be no ambiguity, they

they are too enlightened to be imposed upon, and induced to give the practice a countenance and support to which it may have no claim.

VI. *An Analysis of the Waters of two Mineral Springs at Lemington Priors, near Warwick; including Experiments tending to elucidate the Origin of the Muriatic Acid.* By WILLIAM LAMBE, M. A. late Fellow of St. John's College, Cambridge. From the Memoirs of the Literary and Philosophical Society of Manchester, Vol. V. Part I.

THE author of this ingenious paper has shewn himself a master in the art of analysis. The apparent discovery of the origin of the muriatic acid, to which Mr. Lambe's labours have led, is so well worthy of the attention of philosophers, as it may lead to a discovery of the composition of other acids whose bases are at present unknown, that we have not a doubt but the path he has laid open will be explored by all the able chemists of Europe.

After some very pertinent introductory remarks, the author observes, that as both the springs rise many feet below the earth, it seems needless to enter into any particulars concerning the nature of the surface, or the qualities of the soil of the circumjacent district, and therefore proceeds to the objects of his enquiry as follows:

ON THE WATER OF THE NEW BATHS.

The spring was discovered in the year 1790, at the depth of 42 feet from the surface of the ground. A well is sunk about 24 feet deep. In the course of this depth there is a rock the thickness of 8 or 10 feet; afterwards a bed of marl; after penetrating which, another rock, much harder than the former, is found. Through this second rock a bore is made 18 feet deep, where there is a small cleft in the rock. There are many little springs found in this course;

but from this cleft the water rises with violence to the level of 4 feet above the surface of the ground; and it affords a constant and copious supply of fresh water.

I. ON THE GASEOUS FLUIDS.

The water, when fresh drawn, smells of sulphurated hydrogen, or *hepatic* * gas; but it quickly becomes inodorous by exposure to the atmosphere. I have obtained no more than 4 cubic inches of gaseous fluid from a wine-gallon of the water. Of these, hardly half a cubic inch is absorbed by the water; and, 1. Nitric acid dropped into this solution causes a minute precipitate of sulphur; hence some hepatic gas has been expelled by the boiling. 2. I put some of the water, which had not been boiled, into a bottle, leaving a part of the bottle empty: I then filled the bottle entirely with lime-water, and stopped it. A white precipitate fell, which, with the addition of distilled vinegar, effervesced sensibly, but not strongly. The half cubic inch is, therefore, mostly carbonic acid. 3. Into the portion of the air which was not absorbed by water, I plunged a lighted candle; it was instantly extinguished. This portion is, therefore, azotic gas.

II. THE SPONTANEOUS PRECIPITATE.

A sediment falls to the bottom, and adheres to the sides of the bath. It is of a yellow colour, and acquires additional brightness by exposure to the atmosphere. A similar sediment may be separated by boiling the fresh water. From a gallon of water, .75 of a grain is procured. This dissolves readily in acids, and shews all the common and well known appearances of oxyd of iron. It must have been united with the carbonic acid, which has been already detected. (1, 2.)

* I must take leave to retain this name in the following pages, preferring it (if for no better reason, at least for its shortness) to the compound term.

III. SOME ANOMALOUS APPEARANCES WITH PRECIPITANTS.

1. After the spontaneous precipitate has been separated, a little oxygenated muriate of mercury was dissolved in a glass full of the water. A white matter separated during the solution, and, in some hours, collected in considerable quantity.

2. A piece of sulphate of argill was dropped into a jar of the same water; presently a stratum of white matter was formed at the bottom of the jar: but this appearance is transitory; for in the course of an hour or two the precipitate is re-dissolved, and the water resumes its transparency. This is an appearance which I had not found noticed by writers on the subject, though I have reason to think it not uncommon. The waters of Astrop, near Banbury, contain carbonate of lime dissolved by the carbonic acid: and, when the carbonate has been separated, by boiling the water, the same appearance is produced by sulphate of argill. Its origin, and that of the decomposition of the mercurial salt, will be shewn in the sequel.

IV. THE METALLIC SALTS.

Several phenomena demonstrate the existence of some metallic substance in this water, besides the precipitate already described (II.): but it is so peculiarly combined, or otherwise modified, as to elude, in a great measure, the action of the ordinary re-agents. When the water is boiled in contact with some of the metals, it becomes turbid; and the metal is partly oxydated, and partly dissolved. The iron, which has been used in the construction of the baths, is almost destroyed: the tin, which lined a vessel used as a warm bath for children, has suffered in like manner. If the water be only boiled and poured into a wine-glass with a bright key in it, the liquor becomes turbid before it is cold. Copper seems to resist its action better; but this is only in a low temperature: for, if the water be boiled in a copper

vessel, similar effects are produced; a precipitate is formed, and some copper is dissolved in the water. 1. This is readily proved by putting a bright piece of iron into the liquor, which, in a few hours, acquires a coppery coating*. Lead also I have found to be acted upon.

I examined, with some minuteness, the precipitates formed by iron and by copper. 2. The first is of a yellow colour; and, though it is not magnetic, it may be made so by the flame of a blow-pipe upon charcoal. It consists, therefore, of oxyde of iron, either totally or in part; but whether it is derived from the liquor, or from the iron which was used to procure it, cannot be determined by this experiment. But the following observation demonstrates, that iron is contained in the water itself. 3. The water was boiled in a copper vessel, and the precipitate formed was collected. This is also of a yellow colour; and, exposed to the flame of a blow-pipe on charcoal (like the former precipitate), it became magnetic. It seems also to contain copper; for, precipitating its solution in muriatic acid by ammoniac, the liquor became blue; the colour however was by no means strong.

When the salts of the water have been concentrated by evaporation, copper is acted upon more powerfully; in so much that if a silver spoon be used for the evaporation it is much tarnished, and the salts acquire a cupreous taste and a yellow tinge, though they are colourless if the evaporation be made in glass. These vestiges of the copper must be attributed to the alloy of the spoon.

The appearances I have described surprised me the more, as, from the use of some of the common re-agents, I had formed opposite conclusions. 4. Prussiat of pot-ash, before the water has been boiled, forms a green cloud, but in a

* This remark evinces the strong necessity of a chemical examination of all the substances used as medicines. It is very common to warm the water with a view of quickening its laxative power. It is evident with what caution vessels in which copper is an ingredient should be used for this purpose; or, rather, with what care they should be utterly avoided.

quantity hardly sufficient to precipitate. After boiling there is no decomposition; nor is there any if the liquor be evaporated to half its original bulk. 5. Tincture of galls strikes a purple colour before the water is boiled: after boiling there is a precipitate likewise, but of a dull lemon colour; after a partial evaporation the colour approaches to whiteness. In each of the two last cases, the liquor gradually acquires a deep yellow tinge. In these experiments, we have none of the ordinary signs of iron, except the carbonat (11.), though its existence in the water has been proved beyond question (3).

V. MANGANESE IS DISSOLVED IN THIS WATER.

As zinc is known to have a stronger affinity to acids than the other metals have, I hoped by its mean to obtain some information on the cause of the facts I have described. 1. I boiled, therefore, some of the water in a glazed vessel, in contact with some pieces of zink: a small precipitate was formed, but enough to be collected for examination with the blow-pipe. This was fused with borax; and a globule was formed of a rich red colour, precisely that communicated by *manganese* *. Continuing the fusion, the colour vanished; nor could I make it re-appear by the yellow flame of the blast: probably because the manganese was mixed with another metal. The globule was removed to a silver spoon; and, then, by fusion, it regained the red colour. To avoid the possibility of error, a little manganese, fused with borax in the same manner, was placed beside the red globule; and no difference could be observed in the colour of the two globules, except a slight variety in the intensity †. 2. The *lemon-coloured* precipitate, formed by the
tincture

* For the properties of this mineral see Scheele's Essay on Manganese; or Bergman on the White Ores of Iron.

† I am aware of the observation of Bergman, that zink does not precipitate solutions of manganese. See his Essays, vol. iii. p. 414. But, be-

tincture of galls (iv. 5.), yields the same result. By using a large quantity of the water, I collected sufficient for examination. This I put over a fire on an iron plate: the vegetable part took fire and burnt away: the powder became of an ochry yellow, and was magnetic:—fused with borax by the blow-pipe, it acquired the redness which manganese imparts.

3. The same fact may be proved by a single experiment. It is known that tartrite of pot-ash decomposes salts of manganese by a double affinity; in consequence of which, tartrite of manganese, which is a substance insoluble in water, precipitates*. I poured, therefore, a solution of tartrite of pot-ash into water, and there fell a copious crystalline precipitate. Much iron fell down with the manganese, as might be expected from the affinity between the oxydes of these metals: for, by fusing the precipitate with nitre, green spots were formed on the sides of the crucible.

Tartrite of pot-ash decomposes likewise salts of lime, as is well known; but the tartrite of lime is precipitated in the form of a white powder, which is not sensibly crystalline. But as there is a great abundance of lime in this water (xiv.), it seems probable that it had entered into the composition of these crystals.

Manganese has been but rarely noticed as entering into the composition of mineral waters. The reason, perhaps, is, that it has been seldom looked for, rather than that it seldom exists; since it is now known to be a substance abundantly diffused through the earth. The waters of Astrop, which I have mentioned above (iii. 2.), decompose tartrite of pot-ash, and form a crystalline precipitate when its carbonate of lime has been thrown down by boiling. This water, in these circumstances, hardly affects either tincture of galls or

sides that I describe only what I have seen, it will appear that the salt in question is of so peculiar a nature, that it cannot be expected to obey the usual analogies of the other solutions.

* See Schiele as above.

prussiat of pot-ash. Every chalybeat spring may be suspected to contain some manganese likewise; and should therefore be examined accordingly.

VI. TESTS OF MANGANESE AND IRON.

As I shall have frequent occasion to mention this mixture of oxydes of manganese and iron, I will enumerate the tests I have used, to avoid useless repetitions. These are, 1. The magnet: to this the smallest particle of iron may be rendered obedient, by exposing it to a due heat, on charcoal, by the blow-pipe. 2. The tinge communicated by the process to a globule of borax: this from iron is green or yellow; from manganese it is hyacinthine; or, when the globule is more loaded with the metal, a fine rich red. This colour disappears by the blue conical flame; and may be re-produced by the gentler yellow flame which surrounds the cone. 3. Fusion with nitre, or with carbonate of soda: manganese imparts to them a fine blue colour; but if it be mixed with the oxyde of iron the colour is green.

VII. AN HYPOTHESIS TO EXPLAIN THE CAUSE OF THE PHENOMENA.

The first hypothesis which I framed, to account for the facts in question, was deduced from the well-known property which manganese possesses of oxygenating the muriatic acid. My reasoning was as follows:—Since, during the solution of the black oxyde of manganese in the muriatic acid, a portion of the acid becomes oxygenated, it must follow, that, if this portion should meet and combine with a metallic oxyde, the salt formed by such an union must be superoxygenated. But in the state of oxydation, doubtless, is a great part of the iron which is so abundantly diffused through the earth. Are then the appearances in question the result of these circumstances? In short, are the salts muriat of manganese and oxygenated muriat of iron? In pursuance of this idea I formed some oxygenated muriat of

iron, by mixing some yellow oxyde of iron (the *rubigo ferri* of the shops) with water, and exposing it, by a proper apparatus, to the oxygenated muriatic acid gas. The gas readily dissolves a part of the oxyde, a few bubbles (perhaps of carbonic acid) escaping during the solution. 1. The salt which is formed is deliquescent; colourless; of a pure bitter taste, without any of the sweet astringency of the common salts of iron*. Alkalies precipitate a white oxyde. The mineral acids, also, decompose the salt; and at the same time a white matter, of a crystalline form, precipitates, but an excess of acid re-dissolves the precipitate†. 2. If some metallic iron be digested in a solution of this salt, an ochre precipitates copiously, which is very soluble in acids. Copper also decomposes the salt; but the matter precipitated is in small quantity, and hardly soluble in acids. 3. Prussiat of pot-ash is totally unaffected by this salt; so likewise is tincture of galls when the salt is quite perfect‡; but, after iron has been digested with it, galls communicate a yellow tinge, or even precipitate a brownish matter; still the prussiat of potash has no effect. These properties of the salt bear so strong a resemblance to appearances which I have remarked in the water, particularly in the effects of the metals (iv. 2 & 3.) and the failure of the re-agents (iv. 4 & 5.), that it strongly confirmed me in the hypothesis I had adopted. On pursuing the experiment, however, the analogy failed. I added to the salt of iron very minute quantities of muriat

* By far the best method of making this salt is to put the rust in a saucer, and to put the mixture of manganese and muriatic acid, diluted to avoid a strong effervescence, in a cup on the same saucer; then to cover the cup with an inverted glass: thus the oxygenated vapour will be confined as it is slowly extricated. If distillation is used, the salt can be hardly made free from an astringent taste.

† The sulphuric acid does not re-dissolve the precipitate; the others do. Some further remarks on this subject will be found (xiv. 6.).

‡ I once saw the galls form a white precipitate; but I suspect the oxygenated was contaminated with some common muriatic acid, formed by its decomposition during the digestion.

of manganese ; but how small soever was the quantity used, and however much it was diluted, the manganese was instantly detected by prussiat of pot-ash. I was therefore forced to conclude that, if oxygenated muriat of iron is really an ingredient of this water, it must be formed by a process different from that which I had imagined.

VIII. THE APPEARANCES IN QUESTION ARE PRODUCED BY THE ACTION OF HEPATIC GAS ON IRON AND MANGANESE.

An observation of Bergman, though in part erroneous, has conducted me, as I think, to the true cause of these appearances ; and I am greatly mistaken if its consequences, when fully pursued, are not of considerable importance to chemical science. Bergman has asserted that hepatised water in which iron filings have been kept for some days, in a well-closed vessel, grows *purple* with tincture of galls : if the iron be dissolved by an acid, the colour approaches more to *violet*. He moreover adds, that the solution of iron in hepatised water is *not at all rendered turbid by prussiat of potash* (*Bergman's Essays, Dissertation VII. 4. L.*) This latter fact promised to throw some light on the subject of my enquiry, particularly when it was joined to the fact of the hepatic smell, which the water has when recently drawn (1.). I was the more strongly induced to pay attention to this combination, from the contradiction of another very eminent chemist. Mr. Kirwan has denied that hepatic gas can dissolve iron, or any other metal (*Philosoph. Transac. 1786*). To ascertain this point, I have made numerous experiments with the greatest caution and accuracy that I have been able to apply. The hepatic gas which I have used, was obtained from sulphuret of iron, formed by fusing equal parts of iron and flowers of sulphur ; and (except in some instances, which will be particularly noticed as they occur) was extricated by diluted sulphuric acid. The gas was collected under water ; which method was preferred, to purify it if possible from extraneous

acid. 1. I digested iron filings, previously purified by repeated washings with distilled water, in a solution of hepatic gas in distilled water: the bottle was filled with the solution, and corked. The iron was presently acted upon; numerous bubbles arose, which drove the cork out of the bottle; they were strongly inflammable, and probably, therefore, pure hydrogen gas: the liquor gradually lost its hepatic odour; and at the end of some days it had a smell a good deal resembling that of stagnant rain water; as the bubbles ceased to be produced it recovered its transparency. The liquor was then examined by re-agents. Infusion of galls struck a yellow tinge; prussiat of potash gave a little whitish cloud; nitrate of silver and muriat of barytes, each very minute precipitates; pure potash a yellow precipitate, but not till the liquor had stood an hour or two. The liquor does not deposit any thing, either by exposure to the atmosphere or by a boiling heat: but by this last process something, perhaps a little gas which has escaped the action of the iron, flies off; since the precipitate with nitrat of silver was white after the boiling, which had previous to it been black. Very little can be deduced with certainty from these trials, except the presence of a little sulphuric acid. It seemed of consequence to determine whether this is generated in the process, or is accidental from the sulphuric acid which was used to extricate the gas.

2. To determine this point I repeated the experiment, using the muriatic acid to generate the gas, instead of the sulphuric. In this case, the liquor, as Bergman has said, is not at all rendered turbid by prussiat of potash; neither does the muriat of barytes precipitate any thing: the precipitate by pure potash is now white, but as minute as before: nitrat of silver makes a yellow cloud both before and after boiling; infusion of galls strikes a yellow tinge. Hence it is clear, that hepatic gas, when produced by sulphuric acid, carries with it a little of the acid which cannot be separated by passing it through water. It seems probable also, that a
 little

little muriatic acid is carried up in like manner when this is used to extricate the hepatic gas. We may farther conclude, that though the remark of Bergman on the effect of the prussiat of potash is true; the remark which accompanies it (on the colour produced by infusion of galls) is erroneous. A purple colour is always, I believe, occasioned by extraneous acid; in which case the prussiat of potash is also precipitated. From the same facts we are enabled to detect another error also, into which the same great man has been betrayed. In his analysis of the acidulous waters of Medvi, in Ostro-Gothland (*Bergman's Essays, Dissertation* viii. 6.), he has noticed a residuum of $4\frac{1}{2}$ grains of iron, dissolved partly by hepatic gas, partly by carbonic acid. Now we have seen that there is no decomposition of these liquors by boiling; nor does any oxyde precipitate, how long soever the evaporation be continued. The hepatic gas seems to be totally decomposed: nitric acid dropped into these liquors precipitates nothing.

Are we then to conclude with Mr. Kirwan, that hepatic gas does not decompose iron or any other metal? As the gas itself is decomposed, this, in strict propriety of language, must be allowed to be true; but that some solution is effected during the decomposition the following remarks evince. 3. A piece of clean and bright iron was put into some of the hepatised solution (if I may be allowed so to call it, while its true composition is unknown): it soon became turbid; a copious ochry precipitate fell down; and in 24 hours the whole surface of the iron was covered with rust. 4. Let the solution be boiled in a copper vessel, a precipitate also separates of an ochry colour; but it is smaller in quantity than in the former experiment. 5. Digest a piece of clean iron in the solution after it has been boiled in a copper vessel; much ochry matter still separates; but there is no vestige of metallic copper on the iron plate. 6. Digest copper filings in the liquor in which iron filings have been previously digested; separate the copper filings, and

now

now let a piece of bright iron be put into the liquor; in this case, copper is deposited on the surface of the iron in a metallic state. 7. Put a small piece of sulphat of argill into a glass of the solution, after fresh iron filings have been digested in it; a white stratum forms at the bottom of the glass, but after some time it is re-dissolved, and the liquor resumes its transparency. 8. Put a little oxygenated muriat of mercury into a glass of the hepatised solution; as it dissolves, a white matter collects on the sides, and falls to the bottom of the glass. 9. Infusion of galls, after the fresh iron has been digested with the solution, precipitates the iron of a dark colour; still the prussiat of potash does not become turbid. From all these facts it is clear, that as the iron combines with the sulphur of the hepatic gas, a peculiar substance is formed and dissolved in the water, which has hitherto been unnoticed by chemical writers, as far as has fallen within my information. That this substance is contained in the waters of the spring under our present examination, seems fully established by the concurrent evidence of so many phenomena in which they completely coincide. Compare III. I & 2. IV. 1, 2, 3, 4, & 5.

IX. MANGANESE EXPOSED TO HEPATIC GAS.

To complete the demonstration, it is necessary to examine the action of hepatic gas upon manganese.

I. I digested some black oxyde of manganese in hepatised water: it had been previously purified, by being boiled repeatedly in distilled water*. The hepatic smell of the gas is quickly impaired; and in 24 hours, if enough of the oxyde has been used, it is perfectly destroyed; still the liquor has a peculiar smell, which can hardly be called offensive: no gas is extricated in this process. The liquor, after filtration, was

* The readiest method of purifying this substance is to boil it first in a very large quantity of rain water; after which, a single boiling in distilled water will be sufficient to extract every soluble impurity.

examined by the same re-agents as the hepatised solution of iron (VIII. 1.) with nearly a similar result; a minute quantity of sulphuric acid was detected; prussiat of potash gave a small white cloud; tincture of galls a slight yellow tinge. Repeating the experiment with gas extricated by the muriatic acid, there was, in this case, no trace of sulphuric acid, and the liquor was not at all rendered turbid by prussiat of potash. From both these solutions pure potash separates a very minute white precipitate. 2. But, in one respect, these solutions differed from the solutions of iron; for, by these, nitrat of silver is instantaneously decomposed, and a copious precipitate separates; it is of a dark brown or yellow colour, as if from a combination of sulphur. Oxygenated muriat of mercury let fall a white matter, much more plentifully than from the solutions of iron. Tartrite of potash is decomposed, and a fine crystalline substance is separated, which is the tartrite of manganese.

3. This solution is affected by metals in a manner similar to the solution of iron. A piece of clear iron becomes quickly covered with rust, and an ochry matter separates. If the liquor be boiled in a copper vessel, some matter also separates of the same colour, and the surface of the vessel is evidently acted upon. Thus the analogy between these hepatised solutions and the water of this spring appears to me completely established; and it may be concluded that this water contains a triple compound, the basis of which is iron and manganese, and the solution of which is effected by hepatic gas.

X. ORIGIN OF THE MURIATIC ACID.

The coincidence between the artificial products and the natural waters of the spring is sufficiently proved: another coincidence remains to be considered, much more interesting and more unexpected—the coincidence between the hepatised solution of iron and the oxygenated muriat of iron. I had almost concluded, from the resemblance between the properties

properties of this salt and the phenomena of the water, that the water contains this very salt: now, I conclude, that they contain a matter, be it what it may, produced by the action of hepatic gas on iron. But they are the very same facts which form the basis upon which each separate inference is built:—does it not then follow as a necessary consequence, that the hepatised solution itself contains a muriat of iron highly oxygenated, and that, therefore, *in this process muriatic acid is generated?* This conclusion seems authorised by reason, and experiment has confirmed it.

1. I evaporated a small quantity of the solution (VIII. 1.) in a watch glass to dryness: a bitter deliquescent salt is left behind: on this salt a little strong sulphuric acid was dropped, and paper moistened with ammoniac was held over the glass; white vapours were immediately formed over the glass: some volatile acid is, therefore, separated by the sulphuric acid.
2. I evaporated about 8 ounce-measures of the same liquor, and, as before, dropped a little sulphuric acid on the residuum; in this case a strong effervescence was excited, very pungent acid fumes arose, which, from their smell, were readily known to be muriatic. The same truth was established beyond a doubt by holding a bit of paper moistened with simple water, which made the vapours visible in the form of a grey smoke—a distinguishing characteristic of the muriatic acid. (*Bergman's Essays, Dissertation II. II. b. 3.*) The evaporation had been performed in a copper vessel, except at its close; and though it was carried on very rapidly, the deliquescent matter had acquired a strong cupreous taste.
3. The hepatised solution of manganese (IX. 1.) evaporated to dryness, leaves a deliquescent salt of a peculiar mawkish taste; and it shews the same signs of muriatic acid as the solution of iron, when treated with sulphuric acid in the same way. I have exposed black oxyde of manganese to oxygenated muriatic acid, and find that a deliquescent salt is formed, which is affected neither by prussiat of potash nor tincture of galls;—alkalies separate from it (what I did not expect

expect) white precipitates; tartrate of potash, a crystalline insoluble salt: all properties resembling the hepatised solution of manganese. 4. Common iron rust, purified by boiling in distilled water, was digested in hepatised water. In a day or two the hepatic odour is destroyed, and the liquor has properties similar to that which was formed with the iron filings. The same kind of deliquescent salt is left by evaporation, shewing the same appearances of muriatic acid. However, this liquor resembles the solution of manganese in precipitating nitrate of silver readily, and of a brown colour (ix. 2.). 5. I treated mercury in the same way: no gas escapes in this experiment, as it does with the iron; a black substance is formed; but the hepatic odour was not destroyed, though the hepatic gas was kept in contact with the mercury many weeks. After filtrating the liquor, I boiled it to expel the superfluous hepatic gas. A small portion of the liquor was suffered to evaporate spontaneously: a crystalline matter was left behind of an acrid taste. Another portion was evaporated, with intention to collect more of those crystals; but, by accident, it was left exposed to heat too long, by which it became perfectly dry, and the residuum became quite black. A little sulphuric acid was dropped on this black matter, by which it effervesced strongly, and very pungent fumes arose which had all the properties of muriatic acid.

[*To be concluded in the next Number.*]

VII. *Method employed between Melun and Lieusaint in France, to measure the Base of a Triangle, in order to determine the Length of an Arc of the Meridian. From the Journal de Physique, 1798.*

THE high road between Lieusaint and Melun has lately been the theatre of an operation extremely interesting, which will form an epoch in the history of the sciences. In order

to fix invariably the standard of the *metre* *, two celebrated astronomers, Delambre and Mechain, were commissioned to measure an arc of the meridian, by a series of triangles carried from Dunkirk to Barcelona †. To calculate the sides of these triangles, it was necessary to set out from a primitive base. None of those measured for the meridian of 1740 had been determined with sufficient accuracy, and some errors were suspected. As the base nearest to Paris, between Villejuif and Juvisy, presented a length of little more than 5000 toises ‡, with considerable inequalities of the ground; the road from Lieufaint to Melun, which gave a length by estimation of 6076 toises, in almost a straight line and with very little variation in the level, was with great reason preferred. To prepare for the measurement of this base, the two signals or observatories, now to be seen, the one at the end of Lieufaint, and the other at the entrance of Melun, were first erected. Within each of these signals a large stone was secured in a piece of strong mason-work, and from this stone arose a cylinder of copper, fastened into it with a mass of lead. The axes of these cylinders, which were fourteen lines in diameter, corresponded perpendicularly with the upper points of the signals. As the line of the base formed towards the middle a small bending, the angle was measured, and found to be $179^{\circ} 11'$, which produced in the total length a difference of $10\frac{1}{2}$ inches. Departing from the

* See the preceding table of the new French measures. EDIT.

† It was proposed to extend this labour to Majorca; but it was found impossible to proceed to that station, on account of the too great distance of the signals.

‡ The object of Delambre and Mechain's labour being to establish a relation between the old and the new measures, and this labour having been begun in 1791, it was necessary that the measurement should be expressed in toises, and fractions of a toise; the use of which could not be abandoned till the *metre* was exactly determined. The commission of weights and measures gave, according to the ancient mode of calculation, a provisional metre, the approximation of which is more than sufficient for common uses. This metre surpasses the half toise by 11.44 lines.

summit of this angle, poles in the direction of each of the signals were erected, at the distance of every hundred toises. At the bottom of each of these poles, a wooden wedge was driven into the ground to such a depth that nothing could alter its position, and the place of each of the wedges was marked by heaps of stones disposed along the road.

After these preliminary labours, Delambre began the operation of measurement on the 5th of Floreal, at the base of the signal of Melun. The instruments constructed for this purpose were four rules of platina, each two fathoms in length (at a given temperature); six lines in breadth, and two thirds of a line in thickness. Each rule was mounted on a piece of wood, sufficiently strong to be secure against all warping and bending; and was covered, at the distance of three inches, with a slight case of wood, at the two extremities of which arose two points made of iron, to serve as marks to direct the sight. On the rule of platina there was placed another rule of copper of the same strength, but somewhat less in length, which served to measure the expansion of the platina. It is well known by experience, that the expansion of platina is to that of copper as 12 is to 25. The two rules were fixed upon each other, in an invariable manner by their anterior extremity, in order that the effect of the expansion might be carried entirely to the other extremity. The rules being plunged into melting ice, and consequently at 0° of Reaumur's thermometer (32° Fahr.), the extremity of the copper coincided on the platina at a line marked; but as soon as they were exposed to another temperature, the copper extended on the platina, on account of the different expansion of the two metals. An ingenious apparatus constructed on this principle, afforded, with the assistance of a nonius and microscope fitted to it, the means of estimating the dilatation of the platina to nearly $\frac{1}{300000}$ of a toise. This apparatus formed at the same time a very sensible metallic thermometer, each part or degree of which corresponded to a dilatation of 0,000009245 of a toise, on each

each rule of the platina*. The four rules were placed at the end of each other, supported by iron tripods mounted on three screws, to make the extremities correspond at equal heights, and brought into a line by marks to direct the sight, placed successively on the wooden wedges before mentioned. Had each rule been placed in immediate contact with its neighbour, the operator in placing one rule might have deranged the preceding, and the contact besides would never have been perfect. To prevent this inconvenience, care was taken to leave a sufficient interval from one rule to another; but the extremity of each rule was furnished with a small rule, or slip of platina, which could be pushed into a groove to fill up the interval, and to form a perfect contact with the following rule: a scale fitted with a nonius, viewed through a microscope, measured the length of the small rule, to nearly $\frac{1}{100000}$ of a toise. But in thus measuring a line on ground, which often rises or falls insensibly, it was necessary to pay great attention to the differences of the level. For this purpose the case of each rule had, at equal distances from its extremities, two small cubes made of copper, which rose to equal heights on the plane of the rules; and upon which were laid the two branches of a square, bearing a spirit level. This level being twice placed on each rule, in the two contrary directions, gave the mean inclination almost to a minute; so that with a very simple formula each measure was found reduced to the horizontal line, and the series of observations gave at the same time the complete level of the base. In commencing the operation, the first rule was placed in such a manner that the centre of a plummet, suspended at its anterior extremity, should fall exactly on the centre of the copper cylinder, already mentioned, which

* Allusion is made here not to common thermometers, but to newly invented metallic thermometers, divided according to a new decimal scale, of which 2.316 parts correspond to one degree of Reaumur. To express, therefore, that degree of expansion of the platina, 0.00009245 must be multiplied by 2.316, which gives a little more than 0.0002.

formed a point of departure under the signal of Melun. The rules 2, 3 and 4 were placed in a series after the first, and brought into a line with the sight. The small rules, or slips, were pushed in to fill up the intervals; and the lengths of these slips, as well as the expansion of each rule, and the observations of the level, read by Delambre, were written, as he dictated, by two assistants, who each held a paper divided into columns for that purpose. After this the first rule was removed and placed after the fourth rule, and the same operation was repeated, directing the line always by the sight-points, removed successively at the distance of every hundred toises, and taking care at each change of the rule to read the expansion, the length of the slip, and the two observations of the level.

This operation being repeated 3021 times, rendered it consequently necessary to make 6042 observations by the microscope, and as many of the level. This was continued without interruption during the day; and when night obliged the operators to suspend their labour, the following method was employed to fix the point where they left off, and which was to serve next morning for the point of departure. Towards the extremity of the last rule an iron stake was sunk into the ground, and a pretty deep hole dug around it. The iron stake was then removed, and its place supplied by a wooden stake, on the surface of which was nailed a plate of lead. The last rule was placed in such a manner that a plummet, nicely adjusted and suspended from its extremity, should fall on this plate; the point where it touched the lead was marked as exactly as possible, and the wooden stake was defended by a strong covering of wood, which was itself covered with earth, so that carriages could pass over it without causing any derangement. Things remained in this state till next morning, when the operations were resumed in the like manner as that of the first day. The whole operation lasted forty days, three of which only were interrupted. The operators generally advanced eighty-eight lengths of

the rule everyday. On the 15th of Prairial at noon, Delambre arrived at the cylinder of copper, forming the other extremity of the base, under the signal of Lieusaint; the extremity of the last rule was found to pass the centre just $48\frac{1}{2}$ lines; and this deduction being made, as well as all the necessary calculations, the result was a length of 6075,784689 toises.

Though these details are sufficient to enable the reader to judge of the great precision employed in this operation, Delambre added many other ingenious and nice precautions which are too long to be repeated here, and which ensured to his labour the highest degree of exactness possible. We shall only add, that, by the accuracy of the instruments and methods employed, errors of inches and seconds are as little to be presumed in the present measurement, as errors of toises and minutes were formerly. This great perfection is chiefly owing to the labours of Borda.

VIII. *Chemical Reflections on the Effect produced by Mordants in dyeing Cotton red.* By. J. A. CHAPTAL. From the *Annales de Chimie*, Vol. XXVI.

IN regard to the beautiful red colour given to cotton by means of madder, the case is the same as with certain pharmaceutical preparations, the ridiculous receipts for preparing which have been hitherto respected, because apprehensions have been entertained that their effect would be altered by introducing the least change in the process. A month's labour would scarcely be sufficient to terminate all the operations which have been judged indispensibly necessary for obtaining that beautiful colour called the Turkey or Adrianople red. Soda, oil, gall nuts, sumach, the sulphate of alumine, blood, the gastric liquor, madder, soap, the nitro-muriate of tin, are employed in succession. The true means of simplifying this process is not to labour at hazard, and to make trial of the different methods practised without a

guide and without principles. Such a proceeding conducts rarely and with slow steps to any happy results. I am acquainted but with one method of making progress in the arts, which is, to bring back and reduce all operations to simple principles: by these means we obtain fixed points of departure, to which all results and all our labours may be referred. Chemistry is now sufficiently advanced to supply us with these bases, and nothing therefore is necessary but to establish them. In the hands of the artist they will become what formulæ are in the head of the mathematician. I shall therefore attempt to give an example by subjecting to chemical principles the three chief mordants in dyeing cotton red; viz. oil, gall nuts, and alum.

It is known that cotton does not receive the red of madder in a fixed manner until it has been properly impregnated with oil. The red applied by printing is far from possessing the same degree of fixity, since it will not stand when washed with soda. This preliminary preparation is given to cotton by forming a cold soapy liquor from the combination of oil and a weak solution of soda. The use of this alkaline ley is attended with no other advantage than that of diluting and dividing the oil, and enabling the operator to convey it to all the parts of the cotton in an equal and easy manner. I have found by experience that potash produces the same effect as soda; and, in my opinion, this fact merits some consideration, as soda, which is scarce and dear in the north, may be supplied by potash, which is there common.

From this principle it follows, that all kinds of soda or oil cannot be employed indiscriminately. In order that the soda may have the proper qualities, it must be caustic, and contain little muriate. It must not be rendered caustic by lime, as it then makes the colour brown. Its causticity must be the effect of its calcination.

The carbonate of soda, and soda mixed with much muriate, combine with oil but very imperfectly. Therefore

soda that has been long prepared, or is impure, cannot be applied to the purposes of dyeing in this manner.

The choice of the oil is equally essential as that of the soda. The oil, to be good, must unite very perfectly with the ley of soda, and must remain in an absolute and permanent state of combination. The oil fittest for this dye is not fine oil, but that rather which contains a large portion of the extractive principle. The former does not preserve its state of combination with the soda, and requires such a strength in the ley as would be injurious to the subsequent operations. The latter forms a thicker and more durable combination, and requires only a weak ley of one or two degrees.

The necessity of producing a perfect and intimate combination of the oil and the soda will be readily perceived, by reflecting that the ley of soda is only employed to divide, dilute, and convey the oil in an equal manner to all the parts of the cotton: for it follows from this principle, that if the oil is not well mixed, the cotton made to pass through this mordant will take the oil unequally, and the colour, therefore, will be badly united. Hence it happens that the workman places the whole secret of a well-united and strong colour in the choice of good oil and suitable soda. It thence follows from these principles that the oil ought to be in excess, and not in a state of absolute saturation; for in the latter case it would abandon the stuff in washing, and the colour would remain dry.

When the cotton has been properly impregnated with oil, it is subjected to the operation of being galled. The using of the gall nuts is attended with several advantages: 1. The acid which they contain decomposes the saponaceous liquor with which the cotton is impregnated, and fixes the oil on the stuff. 2. The character of animalisation which the galls have, predisposes the cotton to receive the colouring matter. 3. The astringent principle unites with the oil, and forms with it a compound which blackens as it dries; which

which is not very soluble in water, and which has the greatest affinity with the colouring principle of the madder. The dyer may acquire a competent knowledge of this last combination, and study its properties, by mixing a decoction of gall nuts with a solution of soap.

It follows from these principles : 1. That the place of the gall nuts cannot be supplied by any other astringent, let the quantity employed be what it may. 2. That the galls ought to be strained as hot as possible, that the decomposition may be speedy and perfect. 3. That the galled cotton ought to be speedily dried, in order to prevent its assuming a black colour, which would injure the brightness of the red intended to be given to it. 4. That dry weather ought to be chosen for the process of galling, because in moist weather the astringent principle communicates a black colour, and dries slowly. 5. The cotton ought to be pressed together with the greatest care, in order that the decomposition may be effected in an equal manner at every point of the surface. 6. That a proportion ought to be established between the gall nuts and the soap : if the former predominates, the colour is black ; if the latter, the portion of the oil not combined with the astringent principle then escapes by the washings, and the colour remains poor.

The third mordant employed in dyeing cotton red is the sulphate of alumine (alum). This substance not only has of itself the property of heightening the red of madder, but it contributes also by its decomposition and the fixation of its alumine to give solidity to the colour. To judge of the effects of alum in dyeing cotton, it will be sufficient to mix a decoction of gall nuts with a solution of alum. The mixture becomes immediately turbid, and there is formed a greyish precipitate, which, when dried, is insoluble in water and alkalies.

Every thing that takes place in this experiment of the laboratory may be observed in the process of aluming in dyeing. Cotton, when galled and plunged in a solution of the sulfate or acetate of alumine, immediately changes its colour,

and becomes grey ; the bath presents no precipitate, because the operation takes place in the tissue of the cloth itself, where the production remains fixed. It is however to be observed, that if the galled cotton be passed through a too warm solution of alum, a portion of the galls escapes from the tissue of the stuff, and the decomposition of the alum takes place in the bath itself ; which diminishes the proportion of the mordant, and impoverishes the colour.

We have here therefore a combination of three principles (oil, the astringent principle, and alumine) which serve as a mordant for the red dye of madder. Each of them employed separately produces neither the same fixation nor the same lustre in the colour.

This mordant, without dispute, is the most complex known in dyeing, and it presents to chemistry a sort of combination which it is of the utmost importance to study. It is from the precision in this combination, and the judgement shewn by the artist himself to produce it, that a beautiful colour can be expected ; but if it be possible for him to conduct himself through the labyrinth of these numerous operations, by taking the clue of experiment as his guide, it will at any rate be very difficult for him to simplify his progress, or bring it to perfection. It is only by reasoning on his operations, and calculating the result and principle of each, that he can hope to become master of his processes, to correct their faults, and to obtain invariable products. Without this, the practice of the most experienced artist will afford nothing in his hands but the discouraging alternative of success and disappointment. I wished therefore in this short analysis of the process for dyeing red, which is the most complicated of all, to give an instance of what chemistry can do in the arts when its principles are properly applied. I will venture to assert, that the most uninformed workman will here find the principle of his art and the rule of his conduct.

IX. *On a new metallic Substance contained in the Red Lead of Siberia, to which it is proposed to give the Name of Chrome* on account of the Property it possesses of colouring every Substance combined with it. By M. VAUQUELIN. From the Annales de Chimie, Vol. XXV.*

IN proportion as the means of chemistry are multiplied and brought nearer to perfection, we have seen the number of simple bodies increase. Scheele enriched this science with two metallic substances and several acids, &c. and Klaproth lately has made known two new metals and two earths. It appears, therefore, that we are not yet arrived at its utmost boundaries; and, that when mankind shall dig more frequently, and to a greater depth in the earth, many bodies will be discovered, of which at present we have no idea. I will even venture to assert that when chemistry, armed with all the means it possesses at present, shall get possession of all the objects preserved in cabinets with so much care, as so many relics which it is unlawful to touch, it will procure useful discoveries from bodies that at present excite only idle curiosity.

In the year 1789 M. Macquart, a physician at Paris, together with myself, analysed the red lead of Siberia, and announced that this mineral was an intimate combination of the super-oxygenated oxyde of lead and the iron of alumine. Since that epoch Bindheim also said, that he had found in it copper, cobalt, nickel, iron, and the molybdic acid. Some days ago I likewise subjected this substance to a new examination, and I hope to prove that every thing hitherto published on this subject is incorrect; and though I have not yet given to my researches all the extent which I propose, for want of a sufficient quantity of matter, they have been carried far enough to prove that the red lead contains a new metallic acid possessing characterising marks

* From *χρῶμα* colour. EDIT.

well defined, and some properties which may render it applicable to the arts.

Exp. I. A hundred parts of this mineral reduced to a fine powder, were mixed with 300 parts of the saturated carbonate of potash, and about 4000 parts of water; and this mixture was exposed for an hour to a boiling heat. I observed, 1st, that when these matters began to act upon each other there was produced a strong effervescence which continued a long time; 2d, that the orange colour of the lead became a brick red; 3d, that at a certain period the whole matter seemed to dissolve; 4th, that in proportion as the effervescence advanced the matter re-appeared under the form of a granulated powder, of a dirty yellow colour; 5th, that the liquor assumed a beautiful golden yellow colour. When the effervescence had entirely subsided, and appeared to have no longer any action on the substances, the liquor was filtered, and the metallic dust collected on the paper. After being washed and dried, it weighed no more than 78 parts: the potash therefore had taken from it 22 parts.

Exp. II. I poured upon the 73 parts just mentioned, some of the nitric acid, diluted in twelve parts of water, which produced a brisk effervescence. The greater part of the matter was dissolved: the liquor assumed no colour, and there remained only a small quantity of powder of an orange-yellow colour. I separated the liquor of the residuum by the help of a syphon, washed the matter several times, and united the washings with the first liquor. This residuum, dried, weighed no more than 14 parts: from which it follows, that the nitric acid had dissolved 64.

Exp. III. I again mixed these 14 parts with 42 parts of the carbonate of potash and the necessary quantity of water. I then treated them as in Experiment I. and the phenomena were the same. The liquor, after being filtered, was united to the former; and the residuum, washed and dried, weighed no more than 2 parts, which were still red lead, and therefore thrown away.

Exp. IV.

Exp. IV. The two nitric solutions united and evaporated, produced 92 parts of nitrate of lead, crystallised in octaedra, perfectly white and transparent. These 92 parts of nitrate of lead, dissolved in water, were precipitated by a solution of the sulphate of soda. This produced 81 parts of the sulphate of lead, which were equivalent to 56.68 of metallic lead.

Exp. V. The alkaline liquors united, had an orange-yellow colour. They deposited at the end of some days two parts of a yellow powder which contained no more lead. These liquors, subjected to evaporation until a saline pellicle was formed on their surface, produced, on cooling, yellow crystals; among which there was carbonate of potash, not decomposed. These crystals dissolved in water, and the solution united with the mother water, the whole was mixed with weak nitric acid until the carbonate of potash was saturated. The liquor then had a very dark orange-red colour. Being united with a solution of the muriate of tin, newly made, it first assumed a brown colour, which afterwards became greenish. Mixed with a solution of the nitrate of lead, it immediately produced the red lead. Lastly, evaporated spontaneously, it produced ruby-red crystals, mixed with crystals of the nitrate of potash. Ninety-eight parts of this mineral, decomposed as above mentioned, having produced 81 parts of the sulphate of lead, 100 parts would have given 82.65, which are equivalent to 57.1 of metallic lead. But admitting, as experiment proves, that 100 parts of lead absorb, in combining with acids, 12 parts of oxygen, the 57.1 of metallic lead ought to contain in the red lead 6.86 of this principle, and we ought to have for the mineralising acid 36.4.

Exp. VI. To verify by synthesis the proportions of the principles of the red lead found by analysis, I dissolved 50 grains or about 2.654 grammes of metallic lead in the nitric acid; and the solution having been divided into two equal parts, the one was completely precipitated by the necessary quantity

quantity of the combination of the acid of red lead with potash, and I obtained 43 grains, or about 2.282 grammes of red lead, as beautiful as the natural mineral. The other portion of the nitrate of lead, precipitated by caustic potash, gave 28 grains of the white oxyde of lead. Thus, by this synthesis, 100 parts of red lead would be composed of 65.12 of the oxyde of lead and 34.88 of acid. By analysis, as has been shewn, it gives only 1.72* less in the acid which mineralises the red lead—a difference which approaches as near to correctness as chemical means will admit†.

Though the properties above shewn were more than sufficient, strictly speaking, to convince any one well acquainted with the differential characters of metallic substances, that the one in question belongs to a particular species, I thought it my duty to compare its acid by a series of combinations with the molybdic acid, in some properties of which it seems to partake.

Comparative Experiments on the Molybdic Acid and that of Red Lead. The Combination of the former with Potash is distinguished by the Letter A, and the Combination of the latter with Potash by the Letter B.

The combination of the molybdic acid with potash furnishes a salt which has no colour.

The combination of the acid of red lead with potash gives a salt of an orange colour.

A, Mixed with filings of tin and the muriatic acid, immediately becomes blue, and precipitates flakes of the same

* There must be a mistake in some of the cyphers; for the difference between 36.4 given by analysis, and 34.83 obtained by synthesis, is only 1.52. EDIT.

† It is known by the experiments of C Macquart, that the red lead of Siberia contains a small quantity of the water of crystallisation, which amounts to three or four centiemes. It may be possible, therefore, that this difference may be owing to that substance.

colour, which disappears at the end of some time, if an excess of muriatic acid has been added, and the liquor assumes a brownish colour.

B, Treated in the same manner, becomes at first yellowish-brown, and afterwards assumes a beautiful green colour.

A, Mixed with a solution of hydro-sulphure of potash, gives no precipitate, but by the addition of some drops of the nitric acid there is immediately formed a precipitate of a chestnut-brown colour.

B, Mixed with the same reagent, gives, without the addition of the nitric acid, a green precipitate, which, by that acid, becomes yellowish.

A, With a solution of the nitrate of lead, forms a white precipitate, soluble in the nitric acid.

B, Mixed with the same solution, gives an orange precipitate, absolutely of the same shade as that of the red lead pulverised.

A, Mixed with a little alcohol and nitric acid, does not change its colour.

B, Added to the same reagent, immediately assumes a blueish green colour, which preserves the same shade even after desiccation : ether alone gives it the same colour.

A, With a solution of the nitrate of mercury, gives a white flaky precipitate.

B, With the same solution of mercury, gives a precipitate of a dark cinnabar colour.

A, With a solution of the nitrate of silver, forms a white flaky precipitate.

B, With the same reagent, gives a precipitate, which, the moment it is formed, appears of a most beautiful carmine colour, but becomes purple by exposure to the light. This combination, exposed to the heat of the blow-pipe, melts before the charcoal is inflamed. It assumes a blackish and metallic appearance. If it be then pulverised, the powder is still purple; but after the blue flame of the lamp is brought in contact with this matter, it assumes a green colour,

lour, and the silver appears in globules disseminated throughout its substance.

A, With the nitrate of copper, forms a greenish precipitate.

B, With the same solution, gives a chefnut-red precipitate.

A, With the solutions of sulfate of zinc, muriate of bismuth, muriate of antimony, nitrate of nickel, the muriates of gold and platina, produces white precipitates, when these solutions do not contain excess of acid.

B, With the same solutions, produces almost the same phenomena; except that the precipitates are for the most part yellowish. That of gold is greenish.

The Molybdic Acid alone.

1. The molybdic acid melted with borax gives it a blueish colour.

2. Paper dipped in the molybdic acid becomes in the fur of a beautiful blue colour.

3. The molybdate of lead dissolves in the muriatic acid, and the solution does not assume any colour even by ebullition.

Acid of the Red Lead alone.

1. The acid of the red lead melted with borax communicates to it a very dark green colour.

2. Paper impregnated with the acid of red lead assumes in the light a greenish colour.

3. The red lead dissolves even without the application of heat in the muriatic acid, and the solution has an orange-red colour; but by ebullition it assumes a beautiful green colour, and there is formed muriatic acid highly oxygenated.

From the phenomena above mentioned, I entertain no doubt that the acid which mineralises the red lead of Siberia has for its basis a particular metal, hitherto unknown. If it be compared indeed with all the other metals, there will

be found no perfect analogy between them. The uranium does not become acid; it cannot be combined with caustic alkalies, and does not redden vegetable blue colours. Titanium dissolves in acids, produces crystallisable salts, and does not combine with alkalies. Tungsten becomes yellow in acids, without being dissolved; and gives, with alkalies, white crystallisable salts. It would be useless to continue the comparison of this substance with other metals; their properties are too well known; and it is evident that they exhibit no phenomena of the like kind.

[M. Vauquelin's second memoir on the properties of this new metal will be given in the next number of the Philosophical Magazine.]

X. *An Account of the Jumping Mouse of Canada, Dipus Canadensis. By Major General THOMAS DAVIES, F.R.S. and L. S. From the Transactions of the Linnean Society, Vol. IV. 1798.*

AS I conceive there are few persons, however conversant with natural history, who may have seen or known there was an animal existing in the coldest parts of Canada, of the same genus with the Jerboa, hitherto confined to the warmer climates of Europe and Africa; I take the liberty of laying before this society the following observations (accompanied by a drawing) on an animal of that kind, procured by myself in the neighbourhood of Quebec, during my last residence in that country. As I do not recollect to have seen this animal either figured or described by any author in natural history, I flatter myself, these observations may afford some satisfaction to the president and members of the Linnean Society. The specimens from which I made the drawing are now in my collection. With respect to the food, or mode of feeding, of this animal, I have it not in my power to speak with any degree of certainty, as I could by no means procure any
kind

kind of sustenance that I could induce it to eat; therefore, when caught, it only lived a day and a half. The first I was so fortunate to catch was taken in a large field near the falls of Montmorenci, and by its having strayed too far from the skirts of the wood, allowed myself, with the assistance of three other gentlemen, to surround it, and after an hour's hard chase to get it unhurt, though not before it was thoroughly fatigued; which might in a great measure accelerate its death.

During the time the animal remained in its usual vigour, its agility was incredible for so small a creature. It always took progressive leaps of from three to four, and sometimes of five yards, although seldom above 12 or 14 inches from the surface of the grass; but I have frequently observed others in shrubby places and in the woods, amongst plants, where they chiefly reside, leap considerably higher. When found in such places, it is impossible to take them, from their wonderful agility, and their evading all pursuit by bounding into the thickest cover they can find.

With respect to the figure given of it in its dormant state, I have to observe, that specimen was found by some workmen, in digging the foundation for a summer-house, in a gentleman's garden about two miles from Quebec, in the latter end of May 1787.

It was discovered enclosed in a ball of clay, about the size of a cricket-ball, nearly an inch in thickness, perfectly smooth within, and about 20 inches under ground. The man who first discovered it, not knowing what it was, struck the ball with his spade, by which means it was broken to pieces, or the ball also would have been presented to me. The drawing will perfectly shew how the animal is laid during its dormant state.

How long it had been under ground it is impossible to say; but as I never could observe these animals in any parts of the country after the beginning of September, I conceive they lay themselves up some time in that month, or beginning
of

of October, when the frost becomes sharp: nor did I ever see them again before the last week in May, or beginning of June. From their being enveloped in balls of clay, without any appearance of food, I conceive they sleep during the winter, and remain for that term without sustenance. As soon as I conveyed this specimen to my house, I deposited it, as it was, in a small chip-box, in some cotton, waiting with great anxiety for its waking; but that not taking place at the season they generally appear, I kept it until I found it begin to smell: I then stuffed it, and preserved it in its torpid position. I am led to believe its not recovering from that state, arose from the heat of my room during the time it was in the box, a fire having been constantly burning in the stove, and which in all probability was too great for respiration. I am led to this conception from my experience of the snow bird of that country, which always expires in a few days (after being caught, although it feeds perfectly well) if exposed to the heat of a room with a fire or stove; but being nourished with snow, and kept in a cold room or passage, will live to the middle of summer.

The animal above described belongs to Schreber's genus of *Dipus*, and may be characterised

DIPUS CANADENSIS *palmis tetradactylis, plantis pentadactylis, caudâ annulatâ undique setosâ, corpore longiore.*

Fig. 1. Plate VIII, represents the *Dipus Canadensis*.

Fig. 2 shows it in its torpid state.

XI. On the Theory of the Structure of Crystals, by the Abbé HAUR.

From Vol. XVII. of the *Annales de Chimie*.

[Continued from Page 169.]

4. Intermediate Decrements.

THERE are certain crystals in which the decrements on the angles do not take place in lines parallel to the diagonals, but

but parallel to lines situated between the diagonals and the edges. This is the case when the subtractions are made by ranges of double, triple, &c. molecularæ. Fig. 47, (Plate IX.) exhibits an instance of the subtractions in question; and it is seen that the molecularæ which compose the range represented by that figure, are assorted in such a manner as if of two there were formed only one; so that we need only to conceive the crystal composed of parallelopipedons, having their bases equal to the small rectangles *abcd*, *edfg*, *hgil*, &c. to reduce this case under that of the common decrements on the angles. I give the name of *intermediate decrement* to this particular kind of decrease, the progress of which will be better illustrated by the following example.

Synthetic Iron Ore (Fig. 48).

De l'Isle *CrySTALL. graph.*, tom. iii. p. 198 and 199. *var. 9* and 10.

Geomet. charact. Respective inclination of the trapeziums *bego*, *nqgo*, of the rising pyramids $135^{\circ} 34' 31''$; of the edges *cg*, *gq*, $129^{\circ} 31' 16''$. Angles of the trapezium *bego*, *b* or *c* = $103^{\circ} 48' 35''$; *o* or *g* = $76^{\circ} 11' 25''$.

This variety of iron ore, which for the most part appears under the form of two opposite pyramids, rising from a common base, is found at Framont in les Vosges. There are some groupes the surface of which, like the iron ore of the island of Elba, reflects the most lively prismatic colours. The crystals are often so small, that they might be taken for simple tetragonal laminæ; but, on close inspection, the small spots which form the faces of the rising pyramids may be seen.

These crystals, which M. de l'Isle classed among the modifications of the dodecaedron with isosceles triangular planes, have for nucleus a cube which performs the functions of the rhomboid, as in the ore of the island of Elba. The two regular hexagons, by which they are terminated, arise from a decrement by a single range of cubic molecularæ on the angles *c*, *n*, (*fig. 46*) of the nucleus.

To

To form an idea then of the effect of the intermediary law, combined with the preceding, and which gives rise to the lateral trapeziums, let us suppose that $cbpr$ (fig. 49) represents the same square as fig. 46, subdivided into small squares, which are the external faces of as many molecule. If we take these molecule by pairs, so that they form rectangular parallelipedons, having for bases the oblong squares $bngb$, $bgmG$, &c. and if we imagine that the subtractions are made by two ranges of these double molecule, the edges of the laminae of superposition will be successively ranged in lines, as PG , TL , Rp , Sp , kz , yz , &c. and the sum of all these edges will produce two faces which, departing from the angles b, r , will converge, the one towards the other, and will unite themselves on a common ridge, situated above the diagonal cp , but inclined to that diagonal. We shall then have twelve faces as the complete result of the decrement; and calculation shews, that the six superior faces, being prolonged to the point where they meet the six lower faces, will form with them the surface of a dodecaedron, composed of two right pyramids united at their bases. These pyramids are here incomplete by the effect of the first law, which gives the hexagon $abcdru$ (fig. 48) and its opposite*.

5. Mixed Decrements.

In other crystals the decrements, either on the edges or on the angles, vary according to laws, the proportion of which cannot be expressed but by the fraction $\frac{2}{3}$ or $\frac{3}{4}$. It may happen, for example, that each lamina exceeds the following by two ranges parallel to the edges, and that it may at the same time have an altitude triple that of a simple molecule. Figure 54 represents a vertical geometrical section of one of the kinds of pyramids which would result from this decrement; the effect of which may be readily conceived by con-

* The term *synthetic* denotes the combination of decrements, one of which takes place by a single range of simple molecule, and the other by two ranges of double molecule.

sidering that AB is a horizontal line taken on the upper base of the nucleus, *b a z r* the section of the first lamina of superposition, *g f e n* that of the second, &c. I call *mixed decrements* those which exhibit this new kind of exception from the simplest laws.

These decrements, as well as the intermediary ones, rarely exist any where else, and it is particularly in certain metallic substances that I have discovered them. Having tried to apply the ordinary laws to a variety of these substances, I found so great errors in the value of the angles, that I at first believed they were inconsistent with theory. But after I had conceived the idea of giving to this theory the extent of which I have just spoken, I arrived at results so correct, that I no longer entertained any doubt of the existence of the laws on which these results depend.

Reflections on the preceding Results.

All the metamorphoses to which crystals are subjected depend on those laws of structure just explained, and others of the like kind. Sometimes the decrements take place at the same time on all the edges; as in the dodecaedron having rhombuses for its planes, as before mentioned; or on all the angles, as in the octaedron originating from a cube. Sometimes they take place only on certain edges or certain angles. Sometimes there is an uniformity between them, so that it is one single law by one, two, three ranges, &c. which acts on the different edges, or the different angles; as is observed in the two solids of which I shall speak hereafter. Sometimes the law varies from one edge to the other, or from one angle to the other; and this happens above all when the nucleus has not a symmetrical form; for example, when it is a parallelopipedon, the faces of which differ by their respective inclinations, or by the measure of their angles. In certain cases the decrements on the edges concur with the decrements on the angles to produce the same crystalline form. It happens also sometimes that the same
edge,

edge, or the same angle, is subjected to several laws of decrement, that succeed each other. In a word, there are cases where the secondary crystal has faces parallel to those of the primitive form, and which combine with the faces produced by the decrements to modify the figure of the crystal.

I call *simple secondary forms*, those arising from an unique law of decrement, the effect of which entirely conceals the nucleus; and *compound secondary forms*, those which arise from several simultaneous laws of decrement, or from one single law which has not attained to its extent, so that there remain faces parallel to those of the nucleus, which concur, with the faces produced by the decrement, to diversify the aspect of the crystal. I shall soon make new applications of theory to the compound secondary forms, of which syntactic iron ore has already presented us an example.

If amidst this diversity of laws, sometimes insulated, sometimes united by combinations more or less complex, the number of the ranges subtracted were itself extremely variable; for example, were these decrements by twelve, twenty, thirty or forty ranges, or more, as might absolutely be possible, the multitude of the forms which might exist in each kind of mineral would be immense, and exceed what could be imagined. But the power which effects the subtractions seems to have a very limited action. These subtractions for the most part take place by one or two ranges of *moleculæ*. I have found none which exceeded four ranges, except in a variety of calcareous spar, forming part of the collection of C. Gillet Laumont, the structure of which I have lately determined, and which depends on a decrement by six ranges; so that, if there exist laws which exceed the decrements by four ranges, there is reason to believe that they rarely take place in nature. Yet, notwithstanding these narrow limits, by which the laws of crystallisation are circumscribed, I have found, by confining myself to two of the simplest laws, that is to say, those which produce subtractions by one or two ranges, that calcareous spar is susceptible

of two thousand and forty-four different forms : a number which exceeds more than fifty times that of the forms already known*, and if we admit into the combination decrements by three and four ranges, calculation will give 8,388,604 possible forms in regard to the same substance. This number may be still very much augmented in consequence of decrements either mixed or intermediary.

The striæ remarked on the surface of a multitude of crystals afford a new proof in favour of theory, as they always have directions parallel to the projecting edges of the laminæ of superposition, which mutually go beyond each other, unless they arise from some particular want of regularity. Not that the inequalities resulting from the decrements must be always sensible, if the form of the crystals had always that degree of finishing of which it is susceptible ; for, on account of the extreme minuteness of the molecu læ, the surface would appear of a beautiful polish, and the striæ would elude our senses. There are therefore secondary crystals where they are not observed in any manner, while they are very visible in other crystals of the same nature and form. In the latter case, the action of the causes which produce crystallisation not having fully enjoyed all the conditions necessary for perfecting that so delicate operation of nature, there have been starts and interruptions in their progress, so that, the law of continuity not having been exactly observed, there have remained on the surface of the crystal vacancies apparent to our eyes. In a word, it is seen that such small deviations are attended with this advantage, that they point out the direction according to which the striæ are arranged in lines on the perfect forms where they escape our organs, and thus contribute to unfold to us the real mechanism of the structure.

The small vacuities which the edges of the laminæ of superposition leave on the surface of even the most perfect se-

* In my Essay, p. 217 *et seq.* I carried the number of these forms only to 1019, because I had not introduced as an element in my calculation modification of the law of decrements, with the existence of which I not then acquainted.

condary crystals by their re-entering and salient angles, thus afford a satisfactory solution of the difficulty a little before mentioned; which is, that the fragments obtained by division, the external facets of which form part of the faces of the secondary crystal, are not like those drawn from the interior part. For this diversity, which is only apparent, arises from the facets in question being composed of a multitude of small planes, really inclined to one another, but which, on account of their smallness, present the appearance of one plane; so that, if the division could reach its utmost bounds, all these fragments would be resolved into molecule, similar to each other, and to those situated towards the centre.

The fecundity of the laws on which the variations of crystalline forms depend, is not confined to the producing of a multitude of very different forms with the same molecule. It often happens also, that molecule of different figures arrange themselves in such a manner as to give rise to like polyhedra in different kinds of minerals. Thus the dodecaedron with rhombuses for its planes, which we obtained by combining cubic molecule, exists in the granite with a structure composed of small tetraedra having isosceles triangular faces, as I shall prove hereafter; and I have found it in sparry fluor, where there is also an assemblage of tetraedra, but regular; that is to say, the faces of which are equilateral triangles. Nay more: it is possible that similar molecule may produce the same crystalline form by different laws of decrement*. In short, calculation has conducted me to another result, which appeared to me still more remarkable, which is, that, in consequence of a simple law of decrement, there may exist a crystal which externally has a perfect resemblance to the nucleus, that is to say, to a solid that does not arise from any law of decrement †.

* *Mem. de l'Acad.* an 1788, p. 17 & 26.

† *Ibid.* p. 23.

*Various Examples of compound secondary Forms.*Prismatic Calcareous Spar (*Fig. 1. Plate II.*)

Spath calcaire en prisme hexaèdre. Daubenton *Tab. Miner.* edit. 1792, p. 15, n° 6. De l'Isle *Cryſtallographie*, tom. i. p. 514. var. 10.

The bases of this prism are produced in consequence of a decrement by a single range on the angles of the summits baf , gaf , bag , dex , dec , ceg (*fig. 4.*), of the primitive form. The six planes result from a decrement by two ranges on the angles $bd f$, fxg , beg , dfx , dbc , cgx , opposite to the preceding. Let $abd f$ (*fig. 50.*) be the same face of the nucleus as *fig. 4.* The decreasing edges situated towards the angle of the summit a will successively correspond with the lines bi , kl , &c. and those which look towards the inferior angle d will have the positions pointed out by mn , op , &c. But in consequence of the first decrement taking place by one range, we prove that the face which results from it is perpendicular to the axis; and calculation shews, in the like manner, that the second decrement, which takes place by two ranges, produces planes parallel to the axis, and thus the secondary solid is a regular hexaedral prism.

To display farther the structure of this prism let us remark that, in the production of any one $abcnib$ (*fig. 1.*) of the two bases, we may confine ourselves to consider the effect of one only of the three decrements which take place around the solid angle a (*fig. 4.*), for example, of that which takes place on the angle baf , supposing that the laminæ applied on the two other faces, $fagx$, $bagc$, do not decrease but to assist the result of the principal decrement, which takes place in regard to the angle baf . But here these auxiliary decrements are altogether similar to that the effect of which they are supposed to prolong.

The case will be totally different if we apply the same observation to the decrements which are effected by two ranges on the inferior angles $bd f$, dfx , fxg , &c. and which produce

duce the six planes of the prism. For example, if we consider the effect of the decrement on the angle dfx , it is necessary also that the laminæ applied on the faces $afdb$, $afxg$ (fig. 4.), should experience towards their lateral angles afd , afx , adjacent to the angle dfx , variations which second the effect of the generating decrement. But here these variations are intermediary decrements by ranges of double moleculæ.

To conceive a better idea of these variations, let us resume the face $abdf$ (fig. 50.). The variations in question will take place parallel to the lines ce , rx , gz , vy , &c. that is to say, by one range of double moleculæ, and in such a manner that there will always be two laminæ on a level at their edges in the direction of the height. By this it is evident why the laminæ taken from the prism by the first sections are trapeziums, such as $plus$ (fig. 1.), in which the assortment of the small composing rhombuses will be the same as on the trapezium $usop$ (fig. 50.). We may in the like manner assign the reason of the different figures through which the laminæ, successively detached, before arriving at the nucleus, are obliged to pass. But this detail would lead us too far. In a word, I must here repeat, that every thing is included in the effect of the principal decrements: that is to say, in the present case, of those which take place on the superior and inferior angles, or parallel to the horizontal diagonals; and after the first lamina of superposition, the figure of the crystal is given according to this single condition, that the initial faces be prolonged so as to intersect each other.

The prism is susceptible of varying in the length of its axis compared with its thickness, which depends on the different epochs at which the decrements commence, or are supposed to commence. For example: if we suppose that the decrement, which takes place towards the inferior angle, acts alone at first on a certain number of laminæ, the axis of the crystal will be so much the longer as the commence-

ment of the decrement on the superior angles shall have been retarded. This difference of epochs becomes sensible by inspecting the dodecaedron, *fig. 2*, which is one of the results of the mechanical division of the prism. It is there seen that the pentagonal laminæ of the summits, such as *A O I R S*, decrease only by their edge *R S*, which corresponds to the inferior angle *b d f* (*fig. 4.*), while, by their upper parts, they continue to envelop the crystal without experiencing any decrement towards that side; so that it is only on the laminæ most distant from the axis, as that corresponding to *p s u l*, that the two decrements take place at the same time.

The result which we have explained is general; that is to say, that, whatever may be the angles of the primitive rhomboid, the secondary solid will always be a regular hexaedral prism.

Amphitrigonous Iron Ore.

(*Fig. 51* represents this crystal in a horizontal projection, and *fig. 52* in perspective.)

Mine de fer a 24 faces. Daubenton *Tab. Miner.* edit. 1792, p. 30, n° 2. De l'Isle *Crystallographie*, tom. iii. p. 193 et suiv. var. 5; 6, 7.

Geomet. charact. Respective inclination of the triangles *g c n*, *g c d*, &c. from the same summit $146^{\circ} 26' 33''$; of the lateral triangles *b g u*, *b g q*, to the adjacent pentagons, such as *g u t m n*, $154^{\circ} 45' 39''$.

This form is that under which the iron ore of the island of Elba most commonly appears. It results from a decrement by two ranges on the angles *c, n* (*fig. 46.*), to the summits of a cubic nucleus which produces the isosceles triangles *g c n*, *g c d*, *n c d* (*fig. 51* and *52*), and of a second decrement by three ranges on the lateral angles *c b p*, *c r p*, *c r s*, &c. which produce the triangles *m n r*, *r n k*, *u g b*, *q g b*, &c. These two decrements stop at a certain term, so that there remain faces parallel to those of the nucleus, viz. the pentagons *g u t m n*, *b d n k l*, &c. (*fig. 51.*)

The first decrement is the same as that which produces the rhomboidal iron ore already mentioned. The second has this property, that, if its effect were complete, it would give a dodecaedron of isosceles triangles, or composed of two right pyramids united at their bases. In the case of any other decrement by two, four or more ranges, the faces of the dodecaedron would be scalene triangles.

The triangles of the summits are frequently furrowed by *striae*, parallel to the bases gn , dn , gd , of these triangles, and which point out the direction of the decrement.

Analogical Calcareous Spar (Fig. 53).

De l'Isle *Crysallographie*, tom. i. p. 543, pl. 4, fig. 36.

Geomet. charact. Inclination of any one, $imeb$, of the trapezoids of the summits to the corresponding vertical trapezoid $ecpg$ $= 60^\circ 33' 54''$; angles of the same trapezoid, $i = 114^\circ 18' 56''$; $e = 75^\circ 31' 20''$; m or $b = 85^\circ 4' 52''$. Angles of the trapezoid $ehog$, $e = 90^\circ$; $o = 127^\circ 25' 53''$; $g = 67^\circ 47' 44''$; $h = 74^\circ 46' 23''$; of the trapezoid $cegp$, $e = 60^\circ$; $p = 98^\circ 12' 46''$; c or $g = 100^\circ 53' 37''$.

Geomet. propert. 1. In each vertical trapezoid the triangle ceg is equilateral. 2. The height ex of this triangle is double the height px of the opposite triangle cpg . 3. In the trapezoid $ehog$ and the others similarly situated the angle heg is a right angle. 4. If the diagonal gb be drawn, the triangle heg will be similar to any one aof (fig. 4.) of those which would be produced by drawing, in the primitive rhombus, the two diagonals bf , ad . 5. If in the trapezoid $emib$, or any other situated at the summits, the diagonals ei , mb , be drawn, the height el of the inferior triangle meb will be double the height il of the superior triangle mib . 6. The triangle mib is similar to a half of the rhombus of very obtuse spar, divided by the horizontal diagonal; and the triangle meb is similar to a half of the rhombus of the acute spar, divided in the same manner.

The

The numerous analogies by which this variety is connected with different crystalline forms, whether we consider certain angles formed by planes, as the angle beg of 90° , the angle ceg of 60° , or certain triangles obtained by drawing the diagonals of the trapezoids, have induced me to give it the name of *analogical spar*. It is derived from three other varieties mentioned before, viz. very obtuse spar by the trapezoids $emih$, $fiht$, &c.; metastatic spar by the trapezoids $emdc$, $ehog$, $obtz$, &c. and the prismatic spar by the trapezoids $bdck$, $cegp$, &c. which are consequently parallel to the axis.

It often happens that the trapezoids $imeh$, $fiht$, &c. are separated, by an intermediary ridge, from the vertical trapezoids $cegp$, $gozr$, &c. In that case the trapezoids $cdme$, $gebo$, &c. are changed into pentagons. I have here supposed the crystal brought back to the most symmetric figure, that is to say, having its surface composed only of quadrilaterals, as sometimes happens. This variety is found in Derbyshire.

Icosaedral Sulfure of Iron (Fig. 55.).

Pyrite ferrugineuse polyèdre à vingt faces triangulaires.
Daubenton *Tab. Miner.* edit. 1792, p. 30. De l'Isle *Crytallographie*, tom. iii. p. 233, var. 22.

Geomet. charact. Respective inclinations of the isosceles triangles PLR , PSR , $126^\circ 52' 11''$; of any one PNL of the equilateral triangles, to each adjacent isosceles triangle PLR or LNK $140^\circ 46' 17''$. Angles of the isosceles triangle PLR , $L = 48^\circ 11' 20''$; P or $R = 65^\circ 54' 20''$.

This variety results from a combination of the law which produces the octaedron originating from a cube (*fig. 42.*), with that which takes place for the dodecaedron with pentagonal planes (*fig. 19 and 20*). The first law gives birth to the eight equilateral triangles which correspond with the solid angles of the nucleus, and the second to twelve isosceles triangles,

triangles, situated, two and two, above the six faces of the same nucleus. If we had a dodecaedron similar to that of *fig. 20*, and wished to convert it geometrically into an icosaedron, such as that in question, it would be sufficient to make the planes of eight sections pass through it in the following manner, viz. one through the three angles P, N, L, (*fig. 19.*), another through the angles P, M, S, a third through the angles L, R, U, &c. A comparison of the figures 19 and 55 will shew, by the correspondence of the letters, the relation between the two polyedra; but this is an operation merely technical, to which nature could not descend. I shall observe, besides, that the nucleus of the icosaedron, to which we should arrive, would be much smaller than that of the dodecaedron, since the solid angles of the latter nucleus would be confounded with the angles D, C, G, &c. (*fig. 20.*) of the dodecaedron; whereas the other nucleus would have its solid angles situated in the middle of the equilateral triangles MPS, NPL, URL, &c. (*fig. 55.*).

The icosaedron of the sulphure of iron has been confounded with the regular icosaedron of geometry, which differs from it very sensibly, since all its triangles are equilateral. It is demonstrated by theory, that the existence of the latter icosaedron is as impossible in mineralogy as that of the dodecaedron; so that among the five regular polyedra of geometry, viz. the cube, the tetraedron, the octaedron, the dodecaedron, and the icosaedron, the three former only can exist there, in consequence of the laws of crystallisation. It is not uncommon therefore to find them among crystals of various kinds of minerals.

The icosaedron of the sulphure of iron is much less common than the dodecaedron. It is found in solitary crystals. I have one which is complete, and about half an inch in thickness.

Polynomous Petunzé (Fig. 56) *.

Spath étincelant ou feld-spath en prisme à dix pans avec des sommets à deux faces et quatre facettes. Daubenton *Tab. Miner.* edit. 1792, p. 4, var. 2.

Geomet charact. Respective inclination of the narrow planes $onkm$, $cfhg$, to the adjacent planes on each side 150° ; of the planes $ctfg$, $PomN$ to those contiguous to them by the edges tF , PN 120° ; of the heptagon $pGcldez$ to the enneagon $BzebnOPrs$, $99^\circ 41' 8''$; of the trapezium $dafc$ both to the plane $nba fhik$ and to the heptagon $pGtcd ez$, 135° ; of the facet $deab$ or $ABzp$ to the same heptagon, $124^\circ 15' 15''$.

I have not yet observed the petunzé naturally crystallised under its primitive form. This form, such as it is given by the mechanical division of secondary crystals, is that of an oblique prism of four planes (*fig. 58*), two of which, such as $GOAD$, $RBHN$, are perpendicular to the bases $ADNH$, $OGRB$. The other two, viz. $BOAH$, $RGDN$, make, with the former, angles of 120° at the ridges OA , RN , and angles of 60° towards the opposite ridges BH , GD . These planes are inclined to the bases at the place of the ridges GO , BR , $111^\circ 29' 43''$, and at the opposite ridges $68^\circ 30' 17''$.

This form is at the same time that of the molecular. Theory shews that the two parallelograms $GOAD$, $OGRB$, as well as their parallels, are equal in extent; and that the parallelogram $BOAH$, or its opposite, $RGDN$, is double each of the preceding; which may serve to explain the roughness of the sections made in the direction $BOAH$, when compared with those obtained in the directions of the

* I have adopted the name petunzé, which is that given to this substance in China, where it is employed in making porcelain. The word *spar* (*spath*) has become so vague, by the application of it to substances very different in their nature, that it is much to be wished that it were banished from the nomenclature of minerals.

small parallelograms, and which are always extremely smooth and brilliant. Moreover, if the diagonal OR be drawn, it will be found perpendicular to OA and RN ; or, what amounts to the same, will be situated horizontally, by supposing that the ridges OA , BH , &c. have a vertical position. We shall soon have occasion to make use of this observation.

The polynomous petunzé presents the most complicated variety which I have observed among crystals of this kind. To form an idea of its structure, let us suppose that *bpyr* (fig. 57) represents a section of the nucleus AR (fig. 58) made by a plane perpendicular to the parallelograms $GOAD$, $BOAH$, and subdivided into a multitude of small parallelograms, which are the analogous sections of so many molecules. Here the side yr (fig. 57) which is the same section of the cutting plane as $GOAD$, is greater than it ought to be in regard to the side cr (fig. 57), which is the same section as $BOAH$ (fig. 58): but these dimensions are suited to those of the secondary crystal, and here occasion no difficulty, because we may suppose that the primitive form has been extended more in one direction than in another; for this form, as I have already remarked, is only a convenient *datum* for the explanation of the structure, and the crystal consists merely in an assemblage of similar molecules; so that it is the dimensions of these molecules which remain invariable.

This being premised, we shall find, by comparing the figures 56 and 57; 1st, that the plane $fabnklh$ (fig. 56) and its opposite, which correspond to mn, dg , (fig. 57), are parallel to two of the planes of the nucleus, viz. $GOAD$, $BRNH$ (fig. 58), and consequently do not result from any law of decrement; 2d, that the plane $PomN$, and its opposite (fig. 56), which correspond to ao, eg (fig. 57), are also parallel to two of the planes of the nucleus, viz. $BOAH$, $RGDN$ (fig. 58); 3d, that the plane $onk m$ and its opposite (fig. 56), which correspond to on, eg , (fig.

(fig. 57) result from a decrement by two ranges parallel to the ridges AO , NR (fig. 58); 4th, that the plane $cfgh$ and its opposite (fig. 56), which correspond to my , dc (fig. 57), result from a decrement by four ranges parallel to the ridges $GDBH$ (fig. 58); 5th, that the plane $ctFg$ and its opposite (fig. 56), which correspond to fy , ca (fig. 57), result from a decrement by two ranges parallel to the same ridges GD , BH (fig. 58), which decrement takes place on the other side of these ridges. It may be seen by what has been already said, that decrements different in their measure give rise to planes similarly situated, such as $onkm$ and $cfgh$ (fig. 56), which is a consequence of the particular figure of the molecule.

With regard to the faces of the summit, the heptagon $pGtcdez$ (fig. 56) is situated parallel to the base $BRGO$ (fig. 58). The enneagon $BsrPonbez$ (fig. 56) is produced in consequence of a decrement by one range on the angle $OB R$ (fig. 58), or parallel to the diagonal OR ; which decrement does not attain to its full extent, and leaves subsisting the neighbouring heptagon parallel to the base $BRGO$. It may be readily conceived, after what has been said on the position of the diagonal OR , why the line ez (fig. 56), which separates the two large faces of the summit, is situated horizontally, supposing that the planes have a vertical position.

The trapeziums $dafc$, $ApGC$, result from a decrement by one range on the ridges GO , BR , (fig. 58). The facet $deba$ (fig. 56) arises from a decrement by two ranges, parallel to the ridge BO (fig. 58). With regard to the other facet $AB \approx p$, which has the same position as the preceding, in regard to the opposite part of the crystal, it results from an intermediary law by a range of double molecule on the angle $OB R$ (fig. 58). The rhombuses $bclh$, $klfu$ (fig. 57), represent the horizontal sections of two of these double molecule, taken in the same range, and whose relation to the rest of the assortment will become sensible by comparing

comparing the rhombuses in question with those marked by the same letters (*fig. 57*).

The crystals of this variety are subject to a change of dimensions, which is, that the faces *pGtcdex*, *fabnklh*, and their opposites, which are at right angles to each other, are stretched out, in the direction of their breadth, in such a manner that they exhibit the appearance of a quadrilateral rectangular prism, the summits of which would be formed by the faces situated towards the ridges *PN*, *Fz*.

This variety is found in opake crystals, and of a whitish, yellowish, and sometimes reddish colour, in the granites of Auvergne, and of different countries. There are some of them in groups and some single, but the latter are uncommon.

[*To be concluded in the next Number.*]

XII. *Description of the Apparatus employed by LAVOISIER to produce Water from its component Parts, Oxygen and Hydrogen.*

THE discovery made by Mr. Cavendish of the composition of water having effected a complete revolution in the theory of chemistry, it will no doubt gratify many of our readers to see some account of the principal apparatuses which have been contrived to exhibit this phenomenon.

Fig. 1, Plate X. is that used by Mr. Lavoisier. A is a balloon holding about 30 pints, having a large opening, to which is cemented the plate of copper B pierced with four holes, in which four tubes terminate. The first tube *Hh* is intended to be adapted to an air-pump, by which the balloon may be exhausted of its air. The second tube *gg* communicates by its extremity *MM* with a reservoir of oxygen gas, from which the balloon is to be filled. The third tube *dDd* communicates by its extremity *dNN* with a reservoir of hydrogen gas. The extremity *d* of this tube terminates in a capillary opening, through which the hydrogen gas contained

in the reservoir is forced, with a moderate degree of quickness, by the pressure of a column of one or two inches of water. The fourth tube, *GL*, contains a metallic wire, having a knob at its extremity *L*, intended for transmitting an electrical spark from *L* to *d*, on purpose to set fire to the hydrogen gas: this wire is moveable in the tube, that the operator may be able to move the knob *L* to or from the extremity *d* of the tube *Dd*.

The three tubes *dDd*, *gg*, and *Hh*, are all provided with stop cocks.

That the hydrogen gas and oxygen gas may be as much as possible deprived of water, they are made to pass, in their way to the balloon *A*, through the tubes *MM*, *NN*, of about an inch diameter; and these are filled with salts, which, from their deliquescent nature, greedily attract the moisture of the gas: such are the acetite of potash, and the muriat or nitrat of lime. These salts must only be reduced to a coarse powder, that they may not run into lumps, and prevent the gases from passing through their interstices.

Being provided with a sufficient quantity of the oxygen and hydrogen gases (the latter in the proportion of 2 to 1 of the former), and having adjusted every thing properly, as above directed, the tube *Hh* must be adapted to an air-pump, and the balloon *A* exhausted of its air. Next admit the oxygen so as to fill the balloon, and then by means of pressure force a stream of hydrogen through the tube *Dd*, to which set fire by an electrical spark sent down the wire contained in the tube *GL*. By means of the above described apparatus the mutual combustion of these two gases may be continued for a long time, as the operator has the power of supplying them to the balloon from their reservoirs, in proportion as they are consumed *. It appears from the most accurate experiments, that 100 parts of water contain 85 parts of oxygen and 15 of hydrogen by weight.

* In a future number we shall give a plate of the apparatus contrived by Dr. Higgins for the same purpose.

XIII. *Description of the Apparatus contrived by Mr. CAVALLIO for containing Gas of any Kind, and transferring it to Bottles, Bladders, &c.*

FIG. 6, Plate X, shews a section of the vessel A, which may be of glass or tin; B, a funnel, into which is fastened a bent glass tube C; D, is a tube foldered to the funnel, and which with it passes through the cork *a*; E, represents a tube of tin, wood, or other materials, to one end of which a bladder or oiled silk bag is fastened; the other is inserted in the tube D.

The vessel A being filled with the required gas*, whenever it may be necessary to transfer any quantity to a bottle, bladder, &c. an equal quantity of water is to be poured through the funnel B, which will displace the gas, and force it through D into E.

The bent part of the tube C, by always containing some water, prevents the gas from escaping through the funnel; but when the apparatus is to be set by, both the funnel, and the tube D, must be close stopped with corks.

XIV. *Cursory View of some of the late Discoveries in Science.*

[Continued from the last Number, p. 212.]

SENSIBILITY OF PLANTS.

THE cause of this sensibility is still little known. The following is the explanation given of it by Lamarck*: "In my opinion, there exist in the articulations of many

* This is done by taking out the cork with the funnel, &c. filling the vessel with water, and inverting it with its opening under water. Thus, if a tube leading from the apparatus whence the gas is produced, be brought under the mouth of the vessel, the gas will ascend and displace the water till it be full.

† *Memoires de Physique*, p. 288.

plants, and in certain parts of them, particular vesicles which, especially in warm weather, become filled with elastic and very subtle excretory vapours. These vapours, which are accumulated and retained to a certain degree in the vesicles, swell them out, and make them produce an extension in all the moveable parts where they are situated; but on the least shock or agitation the elastic and subtle vapours which fill these vesicles escape, and are exhaled into the atmosphere. The vesicles being then emptied shrink; and the vegetable part, which is not preserved in its extended state, shrinks also, and falls back into the articulation where the vesicle was placed. Soon after the vesicle becomes filled again, though in an insensible manner, and still produces an extension of the leaf-stalk or petiole, which a cause like the former may destroy.

"In the *hedyfarum gyrans*, the vesicles of the bottom of the small leaves being filled to a certain degree, then empty themselves insensibly, become filled again as before, and re-empty themselves in the like manner, without any other determining cause than the effect of their plenitude. But this continued alternation of repletion and evacuation keeps in constant movement the small leaves of the plant, which, when the weather is warm, rise and fall alternately, but in a slow manner."

Shade, or the absence of light, by the coolness resulting from it, causes that evacuation or shrinking of the vesicles just mentioned. Hence the closing up in the evening of certain parts of plants, especially of the leguminous families, to which botanists have given the name of *their sleep*.

It is by these causes, or others analogous, that all the movements of these plants ought to be explained. A great number of plants experience particular movements in the sexual parts at the time of their fecundation. These movements must be produced by the *aura seminalis* *.

IRRITA-

* It may not, perhaps, be improper to take notice here of the following curious circumstance respecting a *conserva* never before found in France,
and

IRRITABILITY OF THE ANIMAL FIBRE.

Notwithstanding the many researches made respecting the cause of this irritability, much is still wanting. Girtanner ascribes it chiefly to oxygen: but the proofs which he gives in support of his opinion do not appear satisfactory; since the air does not seem to have a direct influence on the irritability of the heart. For example, if the vein of an animal be opened, and if a bubble of vital air or oxygen gas can be introduced into it, by means of a small tube, as soon as the air reaches the heart the animal sends forth a cry of pain and expires. Bichet, who made this experiment *, repeated it with atmospheric air, azot, hydrogen, and the carbonic acid gas, and the animal perished in the like manner; but cold water injected into a vein does not produce the like effect. Bichet concludes, that the death of the animal is occasioned by the interception of the air between the columns of the arterial and venal blood. But, in this case, we may rest assured that oxygen gas destroys the animal.

Dr. Menzies observed, that the irritability of the heart preserved itself longer in animals strangled or drowned than in those which perished in gas. He thence concludes, that the particular state which the blood acquires in passing through the lungs, and which gives it those sensible qualities that

and the same represented by Muller in his *Flora Danica*, under the name of *conserua jugalls*, which was communicated, not long ago, to the Philomatic Society at Paris. Citizens Charles and Romain Coquebert having collected some of this *conserua*, in the neighbourhood of Paris, ascertained by means of an excellent microscope, constructed by Nairne and Blunt, that in this species there are male and female filaments, which unite by an actual copulation; that certain globules contained in the male filaments pass into the interior part of the female filaments; and that by this union there are formed in the latter seeds, or, if we may use the expression, small ova, which reproduce the species. This is the first instance in the vegetable kingdom of a reproduction absolutely analogous to that which we find among animals. EDIT.

* Société Philom. page 18.

distinguish the arterial from the venal blood, is not the real cause which gives play to the irritability of the heart, but that its action is particularly owing to the *effect of heat combined with humidity*.

Van Marum, Hildebrant, and other philosophers think that there is a real *irritability* in plants, and particularly in those which have spontaneous kinds of movement. It has thence been asserted, that oxygen has the same effect upon those plants called sensitive, such as the humble plant (*mi-mosa pudica*), the *hedyсарum gyrans*, &c. as upon animals.

Peschier has made several experiments to ascertain whether this opinion was well founded; but oxygen never appeared to him to produce any effect upon these plants. He afterwards examined whether these movements of those plants called sensitive are owing to *real irritability*, like that of animals. The numerous experiments which he made on this subject gave him reason to conclude, that *no real irritability could be ascribed to these plants*, and that all the movements they experience, by the simple touch or otherwise, are merely mechanical; and indeed plants have neither nerves nor muscles, nor any organs analogous to those which, in animals, appear to be the seat of irritability.

This difference in the organization of animals and vegetables cannot be denied; but on the other hand it is equally certain, that what is called *irritability* in animals is owing to mechanical causes. The movement of the muscular fibre in animals is altogether as mechanical as the shrinking of a sprig of the sensitive plant when it is touched. That of the muscular fibre is owing to an efflux of the nervous fluid; that of the sensitive to the efflux of another fluid, which is as little known. But it may here perhaps be said, The animal fibre, such as the heart, is still irritable a long time after it has been separated from the rest of the body, which is not the case with the vegetable fibre. This is true: but it does not prove that it is not always a mechanical cause which acts in these circumstances; its action only is of longer duration;

duration ; for, in whatever manner the action of this muscular fibre be considered, it cannot be moved but by physical causes. The question then will be, to discover what are these physical causes.

It appears very certain that the cause of muscular movement is owing to the nerves, since a part in which the nerves are palsied, or confined by a ligature, has no longer any movement. But how does the nerve move? Some philosophers have compared its movement to the oscillations of an extended cord which is struck: But, 1. The nerves are not extended: 2. They are enveloped on all sides; whereas the cord has no points of contact but at its two extremities.

It appears more probable to others to consider the nerve as one or more vessels constructed almost like the lymphatic vessels; that is to say, composed of a series of vesicles in which flows a fluid called the nervous fluid. I have supposed that this nervous fluid is of a nature analogous to that of the *aura seminalis*. Others have sought for the cause of irritability in electricity, and the experiments on Galvanism seem to give some weight to this opinion.

[To be continued.]

XV. *On the Effects of Oxygen in accelerating Germination.*
From the Journal de Physique, 1798.

MR. HUMBOLDT discovered, in 1793, that simple metallic substances are unfavourable to the germination of plants, and that metallic oxydes favour it in proportion to their degree of oxydation. This discovery induced him to search for a substance with which oxygen might be so weakly combined as to be easily separated, and he made choice of oxygenated muriatic acid gas mixed with water. Cresses (*lepidium sativum*) in the oxygenated muriatic acid shewed germs at the end of six hours, and in common water at the end

of 32 hours. The action of the first fluid on the vegetable fibres is announced by an enormous quantity of air bubbles which cover the seeds, a phenomenon not exhibited by water till at the end of from 30 to 45 minutes. These experiments announced in Humboldt's *Flora Subterranea Fribergensis*, and in his Aphorisms on the chemical physiology of Plants, have been repeated by others *. They were made at a temperature of from 12 to 15 Reaumur. In the summer of 1796, Humboldt began a new series of experiments, and found that by joining the stimulus of caloric to that of oxygen he was enabled still more to accelerate the progress of vegetation. He took the seeds of garden cresses (*lepidium sativum*), peas (*pisum sativum*), French beans (*phaseolus vulgaris*), garden lettuce (*lactuca sativa*), mignonette (*reseda odorata*); equal quantities of which were thrown into pure water and the oxygenated muriatic acid at a temperature of 88° F. Cresses exhibited germs in three hours in the oxygenated muriatic acid, while none were seen in water till the end of 26 hours. In the muriatic, nitric † or sulphuric acid, pure or mixed with water, there was no germ at all: the oxygen seemed there to be too intimately united with bases of azot or sulphur, to be disengaged by the affinities presented by the fibres of the vegetable. The author announces that his discoveries may one day be of great benefit in the cultivation of plants. His experiments have been repeated with great industry and zeal by several distinguished

* See Ussler's Fragments of Phythology, Plenck's Physiology, Willdenow's Dendrology, and *Dictionnaire de Physique* par Gehler.

† The nitric acid, however, diluted with a great deal of water, accelerates germination also, according to the experiments of Candolle, a young naturalist, who has applied with great success to vegetable physiology. This phenomenon is the more interesting, as chemistry affords other analogies of the oxygenated muriatic acid and the nitric acid. Professor Pfafs, at Kiel, by pursuing Humboldt's experiments, has found that frogs suffocated in oxygenated muriatic acid gas increase in irritability, while those which perish in carbonic acid gas are less sensible of Galvanism.

philosophers. Professor Pohl at Dresden caused to germinate in oxygenated muriatic acid the seed of a new kind of *euphorbia* taken from Bocconi's collection of dried plants, 110 or 120 years old. Jacquin and Vander Schott at Vienna threw into oxygenated muriatic acid all the old seeds which had been kept 20 or 30 years at the botanical garden, every attempt to produce vegetation in which had been fruitless, and the greater part of them were stimulated with success. Even the hardest seeds yielded to this agent. Among those which germinated were the yellow bonduc or nickar tree (*guilandina bonduc*), the pigeon cytissus or pigeon pea (*cytissus cajan*), the *dodonæa angustifolia*, the climbing mimosa (*mimosa scandens*), and new kinds of the *homæa*.— There are now shewn at Vienna very valuable plants which are entirely owing to the oxygenated muriatic acid, and which are at present from five to eight inches in height. Humboldt caused to germinate the *clusia rosea*, the seeds of which had been brought from the Bahama islands by Boose, and which before had resisted every effort to make them vegetate. For this purpose he employed a new process, which seems likely to be much easier for gardeners who have not an opportunity of procuring the oxygenated muriatic acid: He formed a paste by mixing the seeds with the black oxyde of manganese, and then poured over it the muriatic acid diluted with water. Three cubic inches of water were mixed with half a cubic inch of the muriatic acid. The vessel which contains this mixture must be covered, but not closely shut; else it might readily burst. At the temperature of 95° the muriatic acid becomes strongly oxydated; the oxygenated muriatic gas which is disengaged passes through the seeds; and it is during this passage that irritation of the vegetable fibres takes place.

XVI. *On the Invention of the Telegraph, with a Description of that proposed by Dr. HOOKE.*

THE idea of conveying intelligence by means of signals, both during the day and in the night-time, is of very great antiquity, as appears by the testimony of several ancient authors; and there is reason to believe that some sort of telegraph was in use even among the Greeks. The destruction of Troy was certainly known in Greece very soon after it took place, and before any person had returned from it. A Greek play begins with a scene, in which a watchman descends from the top of a tower in Greece, and gives information that Troy is taken: "I have been looking out these ten years," says he, "to see when that would happen, and this night it has been done." A night telegraph is also expressly mentioned by Polybius *, who in his tenth book gives a very circumstantial account in what manner the letters of the alphabet may be expressed by means of torches.

It does not appear, however, that this or any other method of the ancients was ever brought into general use, or that any of the moderns had thought of such a machine as the telegraph till the year 1663, when the Marquis of Worcester in his *Century of Inventions* affirmed, that "he had discovered a method by which, at a window, as far as the eye can discover black and white, a man might hold discourse with his correspondent without noise made, or notice taken; being according to occasion given or means afforded, *ex re nata*, and no need of provision before hand, though much better if foreseen, and course taken by mutual consent of parties." This could be effected only by a telegraph, which in the next sentence is declared to have been rendered so perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

* Lib. x. cap. 40.

Forty years after, M. Amontons, an ingenious French mechanic, born at Paris in 1663, and who died in 1705 at the age of 42, proposed the following method: "Let there be people placed in several stations, at such a distance from one another, that by the help of a telescope a man in one station may see a signal made in the next before him: he must immediately make the same signal, that it may be seen by persons in the station next after him, who are to communicate it to those in the following station, and so on. These signals may be as letters of the alphabet, or as a cypher, understood only by the two persons who are in the distant places, and not by those who make the signals. The person in the second station making the signal to the person in the third, the very moment he sees it in the first, the news may be carried to the greatest distance in as little time as is necessary to make the signals in the first station. The distance of the several stations, which must be as few as possible, is measured by the reach of a telescope." Amontons tried this method on a small tract of land, before several persons of the highest rank at the court of France.

Whether the telegraph be a French invention, as that nation asserts*, or whether Amontons' plan for conveying intelligence was founded on the hint thrown out by the Marquis of Worcester, we shall not here examine; but it is certain that the idea of a telegraph, upon a similar construction to those used at present, was suggested by Dr. Hook towards the end

* In *Rapport general des Travaux de la Société Philomatique*, p. 35, the author, speaking of the papers read before the society, says: "Citizen Chappe has at different times given you an account of his experiments, and of the result of those labours by which he has been able to bring the telegraph to its present degree of perfection. At first his discoveries were doubted, and soon after they were carried into execution it was pretended that traces of this invention were to be found in the works of several ancient authors. Experience, however, has already done justice in regard to the first assertion; time will do the same in regard to the second; and the glory of this invention will remain to its author, and to the nation to which he has had the honour of presenting it."

of the last century, and that he gave the first complete description of such a machine, as appears by the following extract from a paper of his, read before the Royal Society on the 21st of May 1684*. "I proposed (says he) some years since, a method of discoursing at a distance, not by sound, but by sight. I say that it is possible to convey intelligence from any one high and eminent place to any other that lies within sight of it, though 30 or 40 miles distant, in as short a time almost, as a man can write what he would have sent; and as suddenly to receive an answer as he that receives it hath a mind to return it, or can write it down on paper. Nay, by the help of 3, 4, or more of such eminent places, visible to each other, lying next in a straight-line, 'tis possible to convey intelligence almost in a moment, to twice, thrice, or more times that distance, with as great a certainty as by writing.

"For the performance of this, we must be beholden to a late invention, which we do not find any of the ancients knew; that is, the eye must be assisted with telescopes, that whatever characters are exposed at one station, may be made plain and distinguishable at the other.

"1st, For the stations: if they be far distant, it will be necessary that they should be high, and lie exposed to the sky, that there be no higher hill, or part of the earth beyond them, that may hinder the distinctness of the characters, which are to appear dark, the sky beyond them appearing white. By which means, also, the vapours near the ground will be passed over and avoided.

"Next, in chusing of these stations, care must be taken, as near as may be, that there be no hill that interposes between them, that is almost high enough to touch the visible ray; because, in such cases, the refraction of the air of that hill will be very apt to disturb the clear appearance of the object.

† The whole paper may be seen in "Philosophical Experiments and Observations of the late eminent Dr. Robert Hooke," published by Mr. Derham. London, 1726.

“ The stations being found convenient, the next thing to be considered, is, what telescopes will be necessary for each station. One of these telescopes must be fixed at each extreme station, and two of them in each intermediate ; so that a man, for each glass, sitting and looking through them, may plainly discover what is done in the next adjoining station ; and with his pen write down on paper the characters there exposed, in their due order ; so that there ought to be two persons at each extreme station, and three at each intermediate ; that, at the same time, intelligence may be conveyed forwards and backwards.

“ Next, there must be certain times agreed on, when the correspondents are to expect ; or else there must be set at the top of the pole, in the morning, the hour appointed by either of the correspondents for acting that day.

“ Next, there must be a convenient *apparatus* of characters, at least, as many distinct characters as there are necessary letters in the alphabet made use of, (as is expressed in Plate X. fig. 5.) And those must be either day characters, or night characters : if they are to be made use of in the day time, they may all be made of deals, and of bigness convenient for the several distances. Any one of which characters may signify any one letter of the alphabet, and the whole alphabet may be varied 10,000 ways ; so that none but the two extreme correspondents shall be able to discover the information conveyed. If the characters are for the night, then they may be made with links or other lights, disposed in a certain order, which may be covered and uncovered according to the method agreed on. There will be also requisite several other characters, which may, for expedition, express a whole sentence ; such as, ‘ I am ready to communicate,’ ‘ I am ready to observe,’ &c.

“ I could instance a hundred ways of facilitating the method of performing this design with the more dexterity and quickness, and with little charge ; but that, I think, will be needless at present, since, whensoever such a way of correspondence

shall

shall be put into practice, those, and many more than I can think of at present, will of themselves occur; so that I do not in the least doubt, but that with a little practice, all things may be made so convenient, that the same character may be seen at Paris within a minute after it hath been exposed at London; and that the characters may be exposed so quick after one another, that a coniposer shall not much exceed the exposer in swiftness; and this not only at the distance of one station, but of a hundred; for, supposing all things ready at all those several stations for observing and exposing, as fast as the second observer doth read the characters of the first exposer, the second exposer will display them to the observer of the third station, whose exposer will likewise display them for the fourth observer, as fast as his observer doth name them to him, or write them down.

“There may be many objections brought against this way of communication, because it has not yet been put in practice; but hardly any that may not be easily answered and obviated.” Dr. Hook illustrates his invention thus:

“Let A B C (Plate X. fig. 4.) represent three very long masts or poles erected; E, the top-piece, that joins them all together; D, a screen, behind which all the deal-board characters hang upon certain rods or lines, and may, by the help of small lines connected with each of them, be exposed at F, or drawn back again behind D, as occasion shall require.”

XVII. *Propositions respecting the Mechanical Power of the Wedge, by Mr. PETER NICHOLSON of Newman-street. Communicated by the Author.*

WRITERS on mechanics, in treating of the wedge, have frequently drawn false conclusions respecting the proportion which exists between the impelling power applied to the head, and the resisting powers opposed to the sides; and
those

those conclusions have resulted from false opinions concerning the directions of the resisting powers.

It is evident, that when wood or other substance is split by a wedge which does not fill the cleft, that is, when the angle of the cleft is more acute than that of the wedge, the power or action of each side of the wedge, equal and opposite to the resistance of the cleft, must be resolved into two; the one in the direction of the side of the cleft, which tends to thrust it forward; and the other perpendicular to that direction, which tends to tear it asunder. It is by not attending to the above resolution that writers on this subject have been led into mistakes; for, instead of considering the powers which act in those two directions, they have imagined a single power only as acting obliquely on each side. But if the sides of the wedge are perfectly polished, as we must here consider them, no single permanent power can be applied to impel any one of them, unless its direction be perpendicular to the plane of the side to which it is applied: therefore two oblique powers, applied on opposite sides of the same point, are at least necessary to sustain each other and the action of the plane; and in the case of the wedge above mentioned, the directions of those two oblique powers will always be perpendicular to each other, as will appear obvious from the two following propositions.

PROP. I. Let ABC (Fig. 3, Plate X.) be a vertical section passing through the centre and at right angles to the head and sides of any isosceles wedge; also in the plane of this section, and at right angles to its sides AB , BC , and CA , let three powers be applied, such, that their directions may all mutually intersect in the axis, and their efforts sustain the wedge in equilibrio; I say, that these three powers are as AB , BC , and CA respectively.

Let LM , KI , ED be the directions of these three powers, which produced, intersect each other and the axis in O . Since, by hypothesis, these three powers directed to the same point are in equilibrio, and the three sides of the triangle ABC are at right angles to their directions; therefore, by a
well

well known statical principle, the intensities of these powers are as AB, BC, and CA respectively.

PROP. II. When an impelling power applied to the head of an isosceles wedge is in equilibrio with the resisting power of a cleft, the angle of which is more acute than that of the wedge inserted, then universally,

The impelling power applied to the head,
The action of the wedge on either side of the cleft,
The part thereof which tends to thrust it forward,
And the remaining part, which tends to tear it asunder,
Are

As twice the sine of half the vertical angle of the wedge,
The radius,

The sine of the angle contained by the sides of the wedge and cleft,

And the co-sine of that angle respectively, the same radius being common.

Let Fig. 2, Plate X. represent a vertical section of the wedge and cleft, similar in position to that described in Proposition 1; also let the two sides of the cleft DH, DH be equal, and in contact with the sides of the wedge AC, AC at equal distances DC, DC from the vertex C, in which case the sides of the wedge make equal angles with those of the cleft. Through either point D, draw DF at right angles, and equal to AC; also through D, draw DE, at right angles to DH, and complete the parallelogram DEFG. Then by Proposition 1, the line AA represents in quantity the impelling power applied to the head, and the line DF represents in quantity and direction the whole action of the side of the wedge on that of the cleft, which by hypothesis is balanced by its resistance; but the power DF is resolved into two, represented in quantity and direction by DG, DE respectively: the one, being in the direction of the cleft, tends to thrust it forward; and the other, being at right angles thereto, tends to tear it asunder.

Therefore the powers mentioned in the Proposition are as AA, DF, DG and DE respectively; but $AC = DF$ being radius, these lines are respectively equal to

Twice

Twice the sine of half the vertical angle of the wedge,
 The radius,
 The sine of the angle contained by the sides of the wedge
 and cleft,
 And the co-sine of that angle. Hence the proposition is
 manifest.

XVIII. *Report of the Commissioners appointed by the National Institute to repeat the Experiments which have been made on Galvanism : read in the Name of the Commission by Cit. HALLE. From the Bulletin des Sciences, par la Société Philomatique, Thermidor, An VI.*

THE commission was not satisfied with repeating a great part of the experiments already made : they classed them, and rendered them complete by the addition of others which were wanting.

I. The phenomenon of Galvanism, taken in general, is as follows : A communication is established between two points of a series of nervous or muscular organs by means of certain determined substances. At the moment when this communication is made, there take place in the state of the organs changes, the nature of which is still unknown ; but which are manifested by sensations more or less lively, or contractions more or less violent. These muscular contractions take place even in separated parts of the body, and with as much force as when produced by the most effectual means of irritation. The series of muscular or nervous organs is called the *animal arc* ; the other substances form the *exciting arc*. The composition of both may be varied many different ways.

II. Among the effects resulting from the different compositions of the animal arc, the following are the most remarkable : A ligature made on a nerve does not intercept Galvanism, unless it be made in the part surrounded with flesh. If the
 nerve

nerve be cut, and its two ends be in contact, Galvanism takes place ; but if they are only brought near to each other, without contact, it is intercepted.

III. Among the effects resulting from the different compositions of the exciting arc, we shall remark the following : The most favourable composition is when it consists of three pieces, each of which is a different metal. One must touch the nerve, and the other the muscle : these are called the *supports*, or *armatures*. The third forms the communication. This is called the *communicator*. But one or two of these may be omitted. Animal bodies, or water, may be placed between them ; or other substances, either metallic combinations, or all other metals, &c. may be substituted in their stead. It has not yet been possible to determine exactly what are the most ineffectual combinations ; but they have been already classed to a certain point, according to the degree of their efficacy. Gold, silver, zinc and tin, are the metals most favourable to Galvanism, when introduced into the exciting arc.

In general a single metal does not act, except when all other circumstances are favourable ; but in that case it has been often seen to act. Error, however, may readily here arise ; for, if one of the ends of the arc be alloyed, in a proportion ever so little different, the arc acts as if there were two metals. By rubbing one end with a different metal, sometimes even with the fingers, or by breathing upon it, efficacy may be communicated to it, under circumstances where it would not otherwise have possessed any.

Oxydes act less efficaciously, *cæteris paribus*, than their metals. Dry carbon acts as an actual metal. It is not intercepted by water and moist substances, nor by the fingers if wet ; but this is not the case if the fingers be dry. The energy of Galvanism is not intercepted or diminished by pieces of dead flesh. The effects of it are sensibly checked by the epidermis ; and they are incomparably greater in
 flayed

slayed animals, or in parts of the human body from which the epidermis has been removed.

It cannot be said that Galvanism is intercepted by all idioelectric bodies; but, on the other hand, it is intercepted by all substances which are strong conductors of electricity. Such are flame, very dry animal bones, the steam of water, glass brought to a red heat, &c.

IV. Galvanism is influenced also by several circumstances foreign to the composition of the two arcs. Such as, 1. The state of the parts which are subjected to the operation: the fresher they are, the stronger are the effects. 2. The longer or shorter exercise of Galvanism: susceptibility of Galvanism is in general excited by exercising it; is exhausted by continuance, and renewed by repose. 3. The succession of various experiments. A disposition of metals which at first had been ineffectual, has become effectual after a different disposition. Two uncertain experiments are hurtful to each other, and become still more so if made in succession. 4. The state of the atmosphere. The atmosphere electric; the animal on which the operation is performed charged and insulated, the effect is the same. The whole apparatus placed under water, the effect remains the same.

V. There are various artificial means to weaken or revive the susceptibility of Galvanism. Thus, a frog exhausted and brought near to a charged electrophorus resumed its susceptibility. Alcohol, on the other hand, weakens and even extinguishes it so as never to return. Potash produces the same effect, only slowly. According to M. de Humboldt, this susceptibility is in many cases restored by oxygenated muriatic acid gas. The commissioners did not observe this circumstance; but they propose to resume the subject, and to repeat several other experiments of that learned philosopher.

They have already repeated those on the action of Galvanism on the heart, and have observed, as he did, that its action is the same as on the voluntary muscles, and that it accelerates their movement.

XIX. *Of an Attempt to make the Maple Sugar above an hundred Years ago. Communicated by Dr. THORNTON, Lecturer on Medical Botany at Guy's Hospital, &c.*

IT appears, by the following correspondence between Dr. Robinson and Mr. Ray, that the property of the American maple of yielding a saccharine juice was known above a century ago, and that attempts were even made to produce sugar from it :

Dr. ROBINSON to Mr. RAY.

"Dear Sir,

London, March 10, 1684.

"I have enclosed you some sugar of the first boiling got from the juice of the wounded maple: Mr. Ashton, Secretary to the Royal Society, presented it to me. 'Twas sent from Canada, where the natives prepare it from the said juice; eight pints yielding commonly a pound of sugar. The Indians have practised it time out of mind; the French begin now to refine it, and to turn it to much advantage. If you have any of these trees by you, could you not make the rial, proceeding as with the sugar cane?"

Answer to Dr. ROBINSON.

"Black Notley, April 1, 1684.

"Yours of the 10th instant I received, and therein an enclosed specimen of the Canada sugar, a thing to me strange and before unheard of. It were well worth the experiment you mention. I therefore engaged a friend and neighbour of mine, an ingenious apothecary, whom I employed yesterday to boil the juice of the greater maple, a tree which grows freely half a mile off from my residence. Having made an extract, he found a whitish substance, like to brown sugar, and tasting very sweet, immersed in a substance of the colour and consistency of molasses. Upon curing, I have no doubt it will make perfect sugar. When it is cured, I will give you a farther account of it."

Here

Here the matter ended ; and after the paper given you on the American maple (see p. 182), I hope the subject will be again pursued with ardour in this country. and this curious investigation turn of profit to this nation.—I shall send you, for your next number, a paper on the mulberry tree, and the rearing of silk-worms.

INTELLIGENCE.

LEARNED SOCIETIES.

DENMARK.

THE Royal Society of Copenhagen has this year proposed a gold medal, value 100 rix-dollars, for the best answer to each of the following questions.

I. HISTORY.

Quænam gentes ante Norvægicos Americam invenerint, et itinera per mare in hanc terræ regionem institerint? Quousque detecta Norvægicorum in America præsertim Austrum versus extensa fuerint? Quæ hac de re constitui poterunt, argumentis et conjecturis ex scriptis, monumentisve, v. c. munimentis, ædificiis, linguis, traditionibus Americanis probanda sunt.

“What nations discovered America, and kept up an intercourse by sea with that country before the Norwegians?
“How far did the discoveries of the Norwegians in America extend towards the South? The proofs and grounds of
“conjecture must be drawn partly from written documents
“and partly from monuments, such as fortifications, edifices, languages and traditions still existing in America.”

II. IN THE MATHEMATICS.

Invenire functionem omnium quantitatum quæ conjunctim determinant magnitudinem effectus calorifici, cujusque materiei igni accipiendo aptæ in re familiari usitatæ, tam ligni, quam cespitis caminariæ et lithantracis, seu carbonum fossilium cujusunque speciei.

Æquatio quæsitæ ad minimum determinanda est pro quatuor diversis casibus. 1^{mo}, Si lignum vel cespes caminarius seu carbones fossiles in fornace deurantur, ut spatium aëris inclusum, e. gr. cubiculi calefieri possit. 2^{do}, Si in foco fluido cuicunque coquendo inservient. 3^{tio}, Si materiæ molli indurandæ, e. gr. in camino laterario lateribus coquendis. 4^{to}, Si materiis duris liquefaciendis, e. gr. metallis sive in clibano sive in ustrina fundendis inservient.

Singulæ æquationes experientia duce ita analysis ope detegendæ et instituendæ sunt, ut ex ipsis computari possit ratio effectus calorifici æque ac usus æconomici cujuscunque speciei ligni, cespitis caminari et carbonum fossilium.

“ To discover the functions of all those quantities which
“ conjointly determine the degree of the effect of heat produced by every combustible substance employed for economical purposes, whether wood, turf, fossil, or pit-coal of
“ whatever species.

“ The required equation must be determined for four
“ different cases. 1st, When the wood, turf, or pit-coal is
“ burnt in a stove, that the inclosed quantity of air, for
“ example of a chamber, may be sufficiently heated. 2^{dly},
“ When they are employed as fuel for boiling any liquid.
“ 3^{dly}, When they are employed for hardening any soft
“ substance, for example, in a brick-kiln for baking bricks.
“ 4^{thly}, When employed for melting hard substances, such,
“ for example, as fusing metals either in an assaying furnace
“ or a melting furnace.

“ Each of these equations must be so deduced from experiment, by the help of analysis, that they may serve for
“ computing the ratio of the effects of the heat and the
“ economical advantages of each species of wood, turf, and
“ pit-coal.”

III. IN PHYSICS.

Experimentis invenire maximum caloris gradum quem calefacti vapores aquei cum aliis corporibus communicare possunt? An ea pars aquæ in olla Papiniana, quæ non in
vapores

vapores calore mutata est majorem, quam 212° Fahren. temperaturam habere potest?

“To determine, by experiments, what is the highest degree of heat which can be communicated to other bodies by the steam of water? Can that part of the water in Papin’s digester which is not in the form of vapour acquire a higher degree of heat than 212° of Fahrenheit?”

IV. IN PHILOSOPHY.

Quinam sunt notabiliores gradus per quos philosophia practica, ex quo tempore systematice tractari cœpit, in eum, quem hodie obtinet, statum pervenerit?

“What are the most remarkable steps in the progress which practical philosophy has made, from the time it was brought into a regular system down to the present period?”

The answers to these questions must be transmitted, post paid, before the end of June 1799, to Professor Abildgaard, secretary to the society. All men of letters, the members of the society alone excepted, are invited to this competition, and their answers may be written in Danish, German, French or Latin. The authors are requested not to insert their names in the title of the papers, but to distinguish them by a motto, which must be inscribed also on a sealed note containing their name and place of residence.

SPAIN.

The Royal Academy of Practical Medicine at Barcelona has proposed the following question as the subject of a prize:

To determine whether cold baths, administered as a preservative or as a remedy to those attacked with disorders of the breast, are useful or prejudicial; and what may be their effects and advantages according to circumstances?

The prize will be a gold medal, value 375 rials; and the memoirs must be transmitted, with the usual formalities, to

the secretary of the academy, in the course of the month of October 1799.

NEW AGRICULTURAL SOCIETY.

A Society for promoting agriculture and manufactures has lately been established in Finland. It will publish its transactions monthly, a thousand copies of which are to be printed in the Finnish, and a thousand in the Swedish language.

FRANCE.

The following prize questions were proposed by the French National Institute of the Arts and Sciences, in the public sitting of Messidor 15th, year VI.

GEOGRAPHY.

To determine what are the grand revolutions which have taken place on the globe, and which are either indicated or proved by history?

The prize will be a gold medal of the weight of five hectogrammes, and will be adjudged in the public sitting of the 15th of Nivose, in the year VIII.

MORAL SCIENCE.

The Class of the Moral and Political Sciences had proposed, for the subject of a prize for the year VII, the following question:

What are the institutions best calculated to found the morals of a people?

The essays transmitted on this subject not having answered the required conditions, the class proposes the same subject again, and in the public sitting of Vendemiaire the 15th, in the year VII, will publish in a new programme some illustrations of this important question. The prize will be five hectogrammes of gold struck into a medal, which will be adjudged in the public sitting of Nivose the 15th, in the year VIII. No answers will be received after the 15th of Vendemiaire, the same year.

CLASS OF THE MATHEMATICAL AND PHYSICAL SCIENCES.

PHYSICS.

This class had proposed, in the year IV, as the subject of a prize to be adjudged in the public sitting of Vendemiaire of the year VII, the uses of the liver in the different classes of animals. This subject so important, which the academy of sciences had proposed in 1792, and which the Institute thought it its duty to continue to hold forth to the examination of the learned, was not treated in the manner it expected. It received only one memoir, in which the question was not in the smallest degree illustrated; and of which the author had wandered into the wide field of the ancient hypotheses, without availing himself of the anatomical and chemical resources pointed out by the Institute in its programme.

This paucity of memoirs, on a subject which concerns one of the noblest and most useful branches of physics, induced the Institute to suppose that the magnitude and extent of the question; the series of the researches necessary for treating it in a proper manner; and above all, the difficulty of finding united in one man the chemical and anatomical knowledge requisite for solving it, were the causes which had deterred competitors from coming forwards. Without abandoning the idea of presenting to the zeal of philosophers a question of so much importance, the Institute has thought proper to divide it into two branches, and to make it the subject of two prizes, by adding to the medal which was to have been adjudged in the year VII, for the whole question, that which it has at its disposal for the present year. It proposes, therefore, as the subject of two prizes, to determine the functions of the liver, separating what relates to the anatomical structure of the hepatic system, from what relates to the chemical examination of the liquids and solids belonging to that system.

The object of the first of these prizes will be: the form, situation, size, comparative weight, and description of the

tissue of the vessels, ducts and appendages of the liver, considered in the principal classes of animals, from man down to insects, moluscæ and worms.

The object of the second will be: an analysis of the hepatic or cystic bile in the different classes of animals as above mentioned.

The memoirs of those who intend to be candidates for one or other of these prizes or for the whole in one essay, must be transmitted, post paid, to the secretary of the class of the mathematical and physical sciences, before the first of Nivose in the year VIII.

The prize for each question will be a gold medal of the weight of a kilogramme; and will be adjudged in the sitting of Germinal 15th, in the year VIII. The memoirs may be written in French or in Latin, or in whatever language the authors choose.

Notice of the Labours of the Class of the Physical Sciences during the preceding three Months: By Cit. LASSUS, Secretary.
Read on the 15th Messidor (July 3d.)

In the class of the Physical Sciences during the last three months, several memoirs were read relating to chemistry, natural history, rural œconomy and medicine, as applicable to animals as well as man. Cit. Guyton, in treating of the anomalies in affinities, shewed that these apparent deviations open to chemists a vast field for new researches. He examined why there is no combination between the azot and oxygen which exist so abundantly in the atmosphere, and in a state of expansion generally so favourable to an union. He likewise pointed out the means of producing it in an apparatus capable of supporting nine or ten times the weight of the atmosphere.

The same chemist employed himself also in the reciprocal decomposition of salts, at a temperature below freezing; a phenomenon, the observation of which is of so much importance

portance in salt works. He discovered the cause of it in the disengagement of caloric, which becomes a disaggregative power. Since chemists have extended their researches to the matter of heat, it is well known that carbon is one of the weakest conductors of it. Pyrometrical experiments have proved to Cit. Guyton, that a body enclosed in carbon does not receive from the same fire but two thirds of the heat received by a similar body placed in siliceous sand. The consequences to be drawn from this fact will serve to improve the processes employed in reduction and fusion.

Chemists have hitherto been checked in many of their experiments, by not being able to increase the intensity of fire. The application of an hydraulic principle to the construction of Macquer's furnace, furnished Cit. Guyton with the means of increasing heat to such a degree, that a crucible of platina began to melt; a circumstance never before observed.

Professor Klaproth, at Berlin, had announced that the colouring matter of the emerald was iron; but the last analyses of Cit. Vauquelin prove that the emerald is composed of siliceous alumine, a particular earth which has been called glucine, and the calx or oxyde of chrome; so that the emerald as well as the beryl or *aigue-marine* are two stones perfectly similar, and composed of the same principles, the colouring matter excepted. (See p. 204.)

By an accurate application of chemical knowledge to the art of dyeing, Cit. Chaptal has discovered a simple and easy process for communicating to cotton a darker or lighter *chamoy yellow* (*jaune chamoi*). By uniting alumine to the oxyde of iron, this chemist has been able above all to give to his colours a soft and velvety appearance, which they can never acquire when that oxyde is employed alone. He has examined the different methods of combining that oxyde with the red of madder, to form a violet colour, and has reduced to simple principles, operations which were exceedingly complicated. He has shewn the reasons why no other astringents, whatever be the dose employed, can be substituted for gall-nuts in dyeing cotton.

To give to the same stuffs that beautiful red colour, known under the name of the Turkish or Adrianople red, dyers employ soda, oil, gall-nuts, fumach, madder, the sulphate of alumine, and several other substances. Cit. Chaptal has examined what is the action of the three principal mordants, oil, gall-nuts, and alum, employed in dyeing cotton; and by describing the most complex and obscure operations in dyeing, he has shewn what chemistry can do towards improving the arts, when the practice of it is directed by a simple and clear theory *.

The employment of soda is not confined to the dyeing of cotton; that brought from Spain is of great use also in soap manufactories, glass-houses for making white glass, and in bleaching. As France expends annually the sum of four millions for that foreign article, it was of importance to encourage the cultivation of the plant which furnishes the soda of Alicant. In this respect Cit. Chaptal and Tessier have been of great service: the first, in proving by the experience of many years, that the plant which furnishes the soda of Alicant may be successfully cultivated on the southern coasts of France; and that the soda it produces is absolutely of the same quality as that of Spain; and the second, by giving all the necessary instructions respecting the cultivation, and burning of the plant in order to convert it into soda.

Some years ago Cit. Clouet, a member of the Institute, had shewn the possibility of converting iron into cast steel, without having recourse to previous cementation. This process, which he has brought to perfection, is the more valuable to the arts which require cast steel, as it may be produced without cementation or natural steel in every place where there is good iron, a mixture of alumine and siliceous earth, and chalk.

It is well known that the goodness of artillery depends, in an essential manner, on the operations which relate to the mixture and fusion of the metal. Tin, which forms a part

* See Chaptal's Paper on this subject, page 274.

of its composition, is exposed sometimes to so great heat while the piece is used, that it becomes fused, which gradually renders the cannon defective. To remedy this inconvenience, Cit. Baumé proposes to harden the copper with nickel, or with what was formerly called regulus of antimony, neither of them being so fusible as tin.

Experiments made at Rambouillet, and in different parts of France, have already shewn the possibility of propagating and preserving in all their purity sheep of the Spanish breed. Cit. Gilbert has communicated on this important point of rural economy the fullest instructions, and given the best founded hopes that these valuable animals may be reared in the territories of the republic, without ever degenerating.

The conquests of our army of the North, by augmenting the riches of the Museum of Natural History at Paris, have given Cit. Lamarck an opportunity of pointing out with precision the distinctive characterising marks of the common cuttle fish (*sepia officinalis*), the calmar or sea sleeve (*sepia loligo*), and poulpe or eight armed cuttle (*sepia octopus*), which had been confounded and classed in one genus. He has rectified an error received among some naturalists, who considered as the animal which forms the argonauta or paper sailer, a poulpe which is accustomed to lodge itself in that shell, in the same manner as the crab called the hermit takes up its lodging in different kinds of shells.

Cit. Cuvier, in a very long memoir on the organs of the voice, shews that the greater part of birds, independently of the inferior glottis, which is the principal organ of their voice, have a superior larynx, by which mechanism they are the more enabled to vary their tones, as by its means they can more easily change the state of their glottis, the length of their trachea, and the aperture of their upper larynx. It results from this organisation, that the gravest tones, and the harmonics of these tones, are produced by a prolongation of the tracheal artery and the greatest relaxation of the glottis; while by a shortening of the trachea, and a contrac-

tion of the glottis, the bird produces tones so much higher as the trachea is shorter, and all the harmonics besides which correspond to that degree of contraction.

Observations which confirm the utility of the muriate of mercurius dulcis in the cure of the small pox, by Cit. Desfarts, as well as the profound researches of Cit. Huzard on a malady which affects the organs of generation in horses, engaged likewise the attention of the class.

Several of its members have made it their particular care to confirm, by repeated experiments, the phenomena of Galvanism. (See Report of the Commission appointed to examine this phenomenon, p. 319.)

PRODUCTION OF SOUNDS BY DIFFERENT GASES.

J. F. JACQUIN, professor of chemistry at Vienna, in a letter to M. Delametherie, gives the following account of some curious experiments which he made lately on this subject: " Professor Chladni at Wittemberg, already celebrated by several discoveries in the theory of the phenomena of sound, induced me, during his residence at Vienna, to make experiments on the property of different gases considered as sonorous bodies; and particularly on that gas which constitutes our atmosphere, and serves as the organ of voice. We took a glass bell furnished at the top with a brass cock, such as that used for filling bladders with gas, and made the internal aperture of the cock to communicate with a small tin flute, about six inches in length. This bell being placed in the pneumatic tub, and filled with gas of any kind, a bladder with a cock, and filled with the same gas as the bell, was fitted to the cock of the bell, and by pressing the bladder gently the flute was made to sound. Comparative experiments were repeated in this manner with atmospheric air, oxygen gas, hydrogen, the carbonic acid, and nitrous gas. The strength of the sound was always the same: but, compared with that in atmospheric air, the oxygen gas gave half a tone lower; azotic gas, prepared different ways,

gave

gave almost always a semi-tone lower; hydrogen gas gave nine or eleven tones higher; the carbonic acid gas a third lower; and the nitrous gas almost the same: a mixture of oxygen gas and azotic gas, in the proportion of atmospheric air, gave again the tone of the last mentioned air, that is to say, a semi-tone higher than each of the compound gases alone. As long as the two gases were not uniformly mixed there was a frightful discord. Chladni has promised to publish a full account of these interesting experiments, which differ entirely from those of Dr. Priestley.

EXPERIMENTS ON ATMOSPHERIC AIR.

On the 14th instant, at 7 o'clock in the evening, Cit. Garnerin and Cit. Beauvais ascended in a balloon from the garden d'Apollon, at Paris. At the height of nearly 400 toises Cit. Garnerin let fall a cage, attached to a parachute, and containing a cat, which fell very gently near the Port-au-Bled. After 20 minutes the balloon descended at Nanteuil, distant from Paris three leagues. At that place, Cit. Beauvais, aide-de-camp to General Moulins, quitted Cit. Garnerin, who departed at half past three in the morning to complete his aerial voyage, by taking a long flight. Cit. Frederic Humboldt, a celebrated philosopher, had begged Cit. Garnerin to fill with air a small flask with a ground stopper. Cit. Garnerin emptied the water which it contained at the height of 669 toises (1303 metres) above Paris. Cit. Beauvais brought back the bottle, filled with atmospheric air, to Cit. Humboldt, who was desirous to know if the carbonic acid gas ascends to such elevated regions.

The observations of Saussure, made on the summit of Mount Blanc (at the height of 2.480 toises), announced its existence there; but this philosopher was in an atmosphere modified by the proximity of rocks. Cit. Humboldt found in the air brought back by Cit. Beauvais, which had not been under the like influence, between 8 and 10 milliemes of carbonic air. Here then is a very heavy aëiform fluid carried to the most elevated regions of the atmosphere.

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The air of Paris, collected on the following midnight, and analysed by means of the nitrous gas and sulfate of iron, was found to contain 0,276 of oxygen gas. The air collected by Cit. Garnerin contained only 0,259 of oxygen. The first was at 103 degrees, the second at 108 of the eudiometer. The air of the high regions was consequently 5 degrees, or 0,017 (almost equal to 0,02) more impure than the air at the earth's surface *. This difference is very considerable, when we reflect that the greatest or least purity of the atmosphere does not differ near the earth's surface but 0,03 of oxygen.

MINERALOGY.

Mr. DONALD STEWART, who has been employed for several years past as travelling mineralogist to the Dublin Society, has lately arrived at Belfast, after having passed over, in his last journey, the counties of Meath, Cavan, Fermanagh, Donegall, Derry, and Antrim. He had before explored the greatest part of the South and West of Ireland. He has made many new and curious observations, and collected numerous specimens, illustrating the natural history, and affording materials for the arts, manufactures, and agriculture of that kingdom.

Though not educated to those pursuits, he has been indefatigable in his researches, and successful in his discoveries; and indeed he appears to be the first person who ever attempted making any general survey of that island with a view to its mineralogy.

Some imperfect accounts of the native plants of Ireland have been published by Rutty, Wade, and some other gentlemen, who, during the residence of Lord Chesterfield as

* It is easy to account for the atmosphere containing more oxygen near the earth than in the higher regions; the vegetables which grow on its surface being the principal agents employed by nature to restore the purity of the atmosphere: but it is not so easy to account for the presence of carbonic acid gas at so great a height. EDIT.

viceroy, formed a society in Dublin under his patronage: but the mines are not described in their essays, nor are there any catalogues of their fossil productions published.

Mr. Stewart has been upwards of twenty years engaged exclusively in this pursuit, and has already deposited 1300 different mineral specimens in the cabinet of the Dublin Society. But as few of his observations have hitherto been laid before the public, the following extract from his notes may prove acceptable to our readers:

“I was enabled,” says Mr. Stewart, “by discovering rich quarries of limestone and marl, in several estates where they were never before known either to tenant or landlord, to be accessary to the fertilization of the most barren lands. In the estates of Lord Palmerston and Ormby Jones, Esq. in the county of Sligo, I afforded the greatest pleasure and advantage to the poor inhabitants, by demonstrating to them that the great rocks, which they called Serpent Rocks, and which they were gazing at with stupid or superstitious admiration for ages, contained most excellent lime. These quarries are at their doors; whereas formerly they carried the scanty pittance of lime they were able to procure from nine or ten miles distance. Having turf at home in abundance, they are now supplied with lime at as cheap a rate as any people in Europe.

“I observed to the priest who accompanied me to the Serpent Rocks, that this must have been the place to which my countryman (St. Patrick) had collected all the serpents of the kingdom. The cliffs extend a mile in front, dip towards the sea westward, and run to an indeterminate length into the country. No block can be raised in these cliffs that is not replete with petrifications; and the fish appear to lie promiscuously as if thrown out of a net. There may be about one-twentieth of the whole rock composed of those petrified fish or serpents. The strata or beds are very regular, and of different thickness. They contain also some large round shells as yellow as gold; so that if chimney-pieces
were

were wrought here they would be very valuable, as the fish and shells would afford very lively and interesting objects upon the polished surface. The Cobham marble is reckoned of great value, from the representation of ruins and landscapes which sometimes appear upon it; but it would fall far short, in my opinion, of the singular and surprising figures with which these rocks abound."

Two small blocks of this stone are deposited at the Dublin Society.

BOTANICAL EXPEDITION.

The following is a list of the objects of natural history, and other curiosities, brought home by Captain Baudin, commander-in-chief of the botanical expedition, in the flute *La Belle Angelique*:—One hundred and ninety casks, containing about 3,500 living plants, and in a state of vegetation; four boxes of zoophytes and lithophytes; a box containing the horns of quadrupeds, and other objects; a box containing vases of porcelain, and other objects; a box of paintings; a box of bows and arrows, and other objects; two boxes of madrepores; two boxes of stuffed birds; two boxes of specimens of wood; a box of quadrupeds and fishes in spirits; two boxes of insects and quadrupeds in spirits; four boxes of plants in spirits; a box of crustaceous animals and polypes; four boxes of seeds; four double boxes of insects; three casks of shells; a cask of melocacti in spirits; living birds; three apes; a crab-eater (*cabien crabier*); eleven planks, and one log of mahogany; a box of miscellaneous articles; a cask of minerals; four boxes of petrifications and eagle-stones (*godes*); a box of bitumen, &c.

THE
PHILOSOPHICAL MAGAZINE.

SEPTEMBER 1798.

- I. *Observations on the Account of the supposed Orang Outang of the East Indies, published in the Transactions of the Batavian Society in the Island of Java. By DE GEOFFROY, Professor of Zoology at the Museum of Natural History. From the Journal de Physique, 1798.*

BARON VON WURMB, the author of this account*, supposing that the object of his examination was that wonderful being, so much celebrated in Europe, by means of which naturalists imagine they can trace out, through shades almost insensible, the gradation from man to animals, made no hesitation to give to his ape the name of the *large orang outang* or *pongo*. But, instead of having an opportunity to observe this singular species, which had occupied so long and in so vague a manner the attention of naturalists and philosophers, and with which, it is said, Maupertuis would have preferred two hours conversation to that of the most learned societies in the world, Wurmb did not even see an ape of the species of the orang outang. His observations, however, are no less valuable, since the object of them is not only a new species, but a species of a peculiar form,

* For Wurmb's description of this animal see page 225.

in which are united,, besides the characterising marks proper to it, and which are not to be found in any other of the mammalia, some others very extraordinary which belong to animals extremely dissimilar. To bring forward then to public notice a dissertation almost unknown, and on an animal, which, though described some time ago, has not yet been comprehended in the catalogues or systems of natural beings, is rendering a real service to science. But this is not enough: it is necessary to prevent that confusion of names which is always followed by a confusion of ideas; for the description of Wurmb, which is not sufficiently ample, and which besides is unaccompanied by a figure, does not afford naturalists the means of ascertaining whether the animal described be rather a new species than the *pongo*; and I have been able to determine this point only by comparing the skeleton of Wurmb's ape with those of different orang outangs preserved in the collection of the Museum of Natural History. This skeleton of Wurmb's ape, one of the most curious and most valuable in the national collection, will furnish us with very important observations, that may serve to give a better idea of the species in question, than a description of the external parts. (See Plate XI.)

This animal, in the scale of beings, occupies almost the last rank in the numerous family of the apes. The singular conformation of its head places it between the mandrills (*simia maimon et mormon* L) and the allouates (*simia seniculus*). However, if, without fixing on this characterising mark, though of great importance, we adhere to those according to which systematic authors have formed for apes genera and divisions, the want of a tail will make it an animal nearly related to the gibbons and orang outangs. But I do not think it necessary to endeavour to prove that the latter mark is very insufficient to point out the real affinity of beings. A tail is a superfluous appendage, and almost foreign to the bodies of animals. This organ can in no case have any influence on their economy, nor even on their

their habits. We might as well say that some species of the genera of the *lemur*, *cavia*, *erinaceus*, &c. which have no tail, are similar to the orang outangs; which would be an absurdity. On the contrary, in a family like that of the apes, where all the principal organs exhibit no remarkable numerical difference, and where the teeth, fingers and tongue have a perfect resemblance, the form of the cranium is the most important consideration in examining the real affinity of these animals, and may serve as a basis for their generic divisions; since it appears that the size and convexity of the cranium indicate sensibility, as the prolongation and size of the muzzle indicate brutality.

But what is most striking in the skull of Wurm's ape is the excessive prolongation of the muzzle; and as this muzzle acquires such a bulk only at the expence of other neighbouring parts, it happens that there is no apparent forehead; that the osseous box which incloses the brain is very small, and that the occipital foramen is situated in the posterior part of the head. The muzzle, the size of which seems to form the principal characterising mark of this species, is remarkable not only for the enormous thickness of the jaw-bones, but also for the extraordinary bulk of the incisive and canine teeth with which it is armed. The incisive exceed in size those of the lion; and the canine, in that respect, are not much different: so that, though these incisive and canine teeth, except in bulk, have a near resemblance to those of other apes, we are tempted to confound the head of the one in question with that of the most carnivorous animals. Another consideration seems in some manner to support this affinity. The occiput rises to a point, and forms a pretty large and thick quadrilateral protuberance, from which arise three osseous ridges, no less apparent and no less solid than those of the lion: two of these ridges proceed in a lateral direction to the auricular apertures, and have from four to five lines of elevation; another proceeds to the vertex, then divides itself above the forehead, like that of the

lion, into two lateral branches, and continues to the external side of the upper edge of the orbits. These small ridges are more distinct in the ape of Wurmb, and form, with the upper edge of the sockets of the eye, an equilateral triangle. But these characterising marks, already so singular in this ape, will astonish us still more by their combination with others at least equally strange. The head has the form of half a pyramid, and the auricular apertures are placed far above the os palatinus; so that a line let fall from the auricular apertures to the internal edge of the os palatinus would form, at the point of its intersection with the horizontal line, an angle of 25° . This has been already observed in the allouate, where such a singular conformation is necessary on account of an extraordinary swelling of the os hioides.

The anatomical reader will, no doubt, be persuaded, after what I have said, that the ape of Wurmb can in no case support itself on its two hind legs, but that it must always go on all-fours. It is, indeed, on the position of the occipital foramen, according to the learned observations of Daubenton, that the greater or less degree of aptitude for walking upright chiefly depends. In man, whose occipital foramen is nearly in the centre of the base of the cranium, the head is placed on the vertebral column in an almost perfect equilibrium; but if the occipital foramen is removed backwards, and particularly to that point where it is observed in the ape of Wurmb, the equilibrium is destroyed; the weight of the head carries with it the body, and obliges the animal to use for its support, and for walking, those anterior extremities which in man serve only for grasping.

Before we can draw any conclusion on this point, in regard to the ape of Wurmb, and before we affirm, that, according to the position of its occipital foramen, it cannot walk on two legs, let us consider it in its whole organisation. We are not yet acquainted with all the immense resources of nature. We do not yet know to what degree it can enlarge, and render useful, organs the rudiments of which only
exist

exist in the greater part of animals to compensate for others which she may have rendered too prominent. But, indeed, all the rest of the organisation of the ape of Wurmb announces a biped animal. Its pelvis is not completely parallel to the spine; its os calcaneum has a flat part, upon which, like man, it may find a solid seat; and, in the last place, its arms have an immoderate length like those of the gibbon, since they reach almost to the external malleolus. This last characterising mark, to which no attention has hitherto been paid, appears to me one of the surest indications of a biped walk. Apes must take advantage of the great length of their anterior extremities, by extending them in all directions; they must make use of them as of a balancing pole to keep themselves in equilibrium, or to restore themselves to it when they have been exposed to a fall which obliges them to make only a gentle inclination of the body.

In a word, a particular organisation rectifies the disadvantages which result, in walking erect, from the length of the muzzle, and the position of the occipital foramen being removed farther back. In all the known mammalia, the spinal apophyses of the cervical vertebræ are shorter than those of the lumbar and dorsal vertebræ. The case is the reverse in the ape of Wurmb; and, according to the judicious remark of Cuvier, these apophyses of the cervical vertebræ have this great length, to form more powerful and more numerous bonds with the large muscles of the neck which proceed on the occipital ridges. Thus nature by another mechanism has provided for the support of the head of Wurmb's ape on the spinal column; and by these means it can keep itself erect, and run in that posture.

I shall not pursue any farther an explanation of the characterising marks which it exhibits to naturalists. I have said enough to prove that it is not the orang outang or pongo, but that it ought to be considered as a species unknown before the publication of Wurmb's memoir. I am far from reproaching that observer for his mistake. At the

time when he wrote his description the natural history of the orang outangs was involved in such obscurity, that he must naturally have considered his ape to be the same animal as the large orang outang or pongo of Buffon. Naturalists were then far from being convinced that this animal, such as it is described in the immortal work of that celebrated author, is an imaginary being to which Buffon has assigned a form and characterising marks, by confounding, under the same name, and in the same description, six different species of apes described by travellers.

II. *Account of the Methods employed in Japan and China to prepare Soy, with some Observations on the Bean from which it is produced. By Professor BECKMANN.*

THIS article, which is a brown saline liquor, imported to Europe from the East Indies, is employed for seasoning various kinds of dishes, and improving the taste of different sauces. It is brought from Japan in small wooden vessels, and also from China and other parts of India in glass flasks, several of which are packed together in a wooden box. The use of it has been long general in the East Indies; where it is placed on the table at each meal, instead of salt, for the purpose of dipping in it flesh, fish, and other kinds of food.

The Japanese are said to be the inventors of this article; and, at present, their soy is preferred to any other; though it is asserted by connoisseurs that this preference arises more from the price than the goodness. In my opinion, it was first introduced in the European commerce in the present century; for it is not to be found in the old catalogues of goods; in Saavary's or Ludovici's dictionaries, nor in the old books on cookery. The first account of the method of preparing it after the Japanese manner was published by Kempfer.

Before I give a description of this method, it may not be improper to inform the reader that the people in India, instead of our common kidney beans, cultivate and use as food another species of a similar kind, called in botany *dolichos*, and which comprehends several species. Among these there is one called *dolichos soya*. This plant is all over rough; and its weak stem rises to the height of a man. Its flowers, which are small, scarcely appear above the calyx, and are of a blueish or almost violet colour. The rough husks contain for the most part only two seeds, which in form, size and taste differ very little from our garden pease, except that they are flattened, shaped somewhat like an egg, and have a black speck at the place where they begin to germinate*.

These seeds form the principal component part of soy. In Japan they are first boiled, and then mixed with the same quantity of barley or wheat meal (the latter is for the purpose of giving the soy a darker colour); and the mixture, being covered up, is deposited for twenty-four hours in a warm place, where it ferments. The same quantity of common salt, with the like quantity and half as much water, is thrown over it; and the whole mass, for the space of two or three months, is stirred round daily with a chocolate stick, and closely covered immediately after. At the expiration of that period it is strained or squeezed through a linen cloth, and the liquor, which is preserved in wooden vessels, becomes always clearer and better the longer it is kept. The mass which remains is again subjected to a like process by having water poured over it, and, being stirred round for some days, as before, is then strained.

* *Hilum fuscum*. The first description and figure of this plant was given by Kempfer in his *Amœnitat. exot.* p. 837, 838. Both these, however, were improved and rendered more complete by Bergius in *Abhandlungen der Schwedisch. Akad.* xxvi. p. 281. The latest descriptions are those of Thunberg in his *Flora Japonica*, p. 282; and Jacquin in *Collectanea ad botanicam et hist. nat.* vol. i. p. 46.

Of the preparation in China the following account has been given by Eckberg, a Swede*: Thirty-five pounds of these beans, clean washed, are boiled for a few minutes with water in a covered vessel, until they can be easily pressed together between the fingers. They are then put into a sieve; and when they are still moist, after the water has run off, they are stirred round in fine meal, made of the same beans, until they are completely covered by it. They are then put into small sieves, or laid upon smooth mats to the height of an inch and a half above each other, and are deposited in a basket covered with mats, where they are suffered to remain three or four days till they begin to grow mouldy. They are then first exposed to the air, and afterwards dried in a strong sun-heat, or in a warm place, until they can bear the stroke of a hammer; when they are rubbed between the hands, and in that manner freed from the meal and mouldiness with which they are covered. They are then thrown into earthen vessels, and a pickle composed of 20 pounds of salt and 100 pounds of spring water is poured over them. These earthen vessels are exposed open during the day to the sun, but at night they are covered; or they are put in some warm place, for the space of six weeks, until their whole substance be well extracted. When it is observed that the pickle has become thick and of a dark brown colour, it is poured off, and boiled several times in order to render it thicker. Some, during these boilings, add to it sugar, ginger and other spices according to pleasure, leaving the whole to stand for a few days; after which it is strained.

From what has been above said, it may be readily perceived that the preparation of soy in Europe would be attended with no difficulty if it were possible to cultivate the beans. Bergius, however, gives his countrymen little hope that this can be done; and chiefly for this reason, that the plant blows so late in green-houses, that the summer is gone before the fruit can ripen. But this is often the case with

* Abhandlungen der Schwedischen Acad. xxvi. p. 40.

exotics which are reared by our gardeners in hot-houses. As they only begin to blow when their nourishment decreases and occasions a stoppage of their growth, the same thing may happen too late in too fertile a soil, or when they have a superfluity of nourishment. On the other hand, when they are transplanted into soil somewhat poorer, and into an open place where they have less shelter, they do not grow so quick and so long; but they blow earlier. And hence it happens, that many exotics planted in the open air produce ripe seeds, which could never be obtained from them while they were preserved as curiosities and favourites of the gardener in green-houses. I consider it, therefore, as an experiment worth making, to plant these beans in the open fields; and I am inclined to think that in many summers they would produce ripe seeds, especially as Jacquin says expressly that they thrive well at Vienna in the open air.

Should my conjecture, however, be not realised, this would not, at any rate, be the case with that of Bergius, who is of opinion that a kind of soy might be obtained from our peas and beans by the same or a similar process; but indeed it would have this great fault, that it would be too cheap, and too soon become common.

III. *Comparative View of the expansive Force of the Steam of Water and that of Alcohol.* By R. PRONY. From the Journal de l'Ecole Polytechnique.

THE experiments from which the following tables are deduced have been described by Bettancourt, their author, in a memoir published in 1790. I gave the results of them, together with a short description of the apparatus used, in the first volume of my *Architeclure Hydraulique*, in treating on the general theory of the application of steam to the movement of machines; but in the second volume, which contains a complete description of steam-engines from the first

invention of them down to the most recent discoveries, I recur to the labours of Bettancourt, which I have explained at full length, as well as the application that may be made of it to physics and the arts*. I refer those, who may be desirous of being thoroughly acquainted with the subject, to that work, and shall here content myself with giving an idea of the apparatus.

The fluid with which the experiments were made was confined in a very strong boiler made of copper, being eight inches at its greatest diameter, and fourteen inches in height. The upper part of it was closed by a cover made of copper also, through which passed three tubes. The first served to introduce the fluid into the boiler, and could be closely shut by means of a screw. The second was occupied by a thermometer, having its ball about two inches above the bottom of the boiler, and the scale, which was on the outside, contained from 0 to 110° of Reaumur. To the third was adapted a bent barometric tube, having two lines of internal diameter, the ascending branch of which was 110 inches in length.

By means of a lateral cock a communication was established between the boiler and an air pump, which served to make a vacuum before a fire was kindled in the furnace below the apparatus. This circumstance of evaporation in a vacuum, forms an essential difference between the experiments of Bettancourt and those made before by Ziegler, and renders them applicable to the theory of the steam-engine, where the vapour acts in a space freed from air.

* In this second volume will be found experiments made on the same object, and communicated to me by their author John Henry Ziegler. They were published at Basle in 1769, in a memoir entitled: *Specimen physico-chemicum de digestione Papini, ejus structura, effectu et usu, primitias experimentorum novorum circa fluidorum à calore rarefactionem et vaporum elasticitatem exhibens*. Bettancourt, who did not see them till he had finished his own, mentions them in his memoir. It will be perceived, by the account I have given of them, that they deprive him of none of that glory which he has a right to expect from his labours.

A vacuum having been made in the boiler, the mercury brought as nearly as possible to a level in the two branches of the barometric tube, and the thermometer reduced to zero by means of ice, the ice was removed, and a fire was kindled, which was excited gently and with much equality, in such a manner that the barometer passed over about a degree per minute. One person then stood by to observe the barometer, and another to observe the thermometer, and each kept a register from degree to degree of the pressure and corresponding temperatures; the pressure being expressed by the height in (French) inches of the columns of mercury, which rose above the level in the long branch of the barometer.

It was exceedingly difficult to prevent either the introduction of air into the boiler, or the extravasation of vapour, according as the internal pressure was less or greater than the weight of the atmosphere: means, however, were found to obviate these inconveniencies; but they are too long to be detailed here, and must be read in the works before mentioned.

The observations of the expansive force of the steam of water furnish 110 results, proceeding from degree to degree of the thermometer, and beginning at zero. These results are contained in the annexed table, where the degrees of pressure are expressed in (French) inches of mercury, and the temperatures denoted according to Reaumur's scale*.

The experiments on the expansive force of the steam of alcohol were made by the same processes, and with the same apparatus, as those employed with the steam of water. The object of them, independently of their general utility in physics, was to make known the relative expences which would be occasioned by these fluids, when used to produce moving forces in steam-engines. This object of research is

* For the convenience of our readers, we have added another column to the table, in which we have given the corresponding degrees of Fahrenheit's thermometer. EDIT.

both important and new. The expence of movement in a steam engine is compounded of the price of the fluid evaporated and that of the fuel. The use of water requires no farther expence than that of the substance employed as fuel; but it is possible that some other fluid, much dearer in itself, may nevertheless have such expansion, that with an equality of pressure the saving in fuel may be greater than the price of the fluid. If the results from the steam of alcohol be compared with those from the steam of water, it will be seen that, at the same temperature, the expansive force of the steam of the former is always more than double that of the latter. Much less fuel then will be necessary to produce in a steam-engine the same effect by alcohol; and if the apparatus were disposed in such a manner as not to lose the condensed liquor, which would be attended with no great difficulty, it might be used with much advantage in certain cases, and in engines of small dimensions. But, according to every appearance, there are other fluids less expensive than alcohol, which may have an equal or even a greater expansion; and it would be a very useful object of research to determine the mechanical effect of which steam is susceptible, and to give tables on that subject, similar to that here presented in regard to water and alcohol.

The results given by experiments, of the expansive force of the steam of alcohol at different temperatures, are expressed in the same manner in the following table, as those given by the experiments on the steam of water.

*TABLE of the Expansive Force of the Steam of WATER
and of ALCOHOL.*

Temperature.		Pressure.		Temperature.		Pressure.	
Reaum.	Fahr.	Water.	Alcohol.	Reaum.	Fahr.	Water.	Alcohol.
0	32	0,00	0,00	56	158,00	7,85	18,85
1	34,25	0,00	0,00	57	160,25	8,40	20,00
2	36,50	0,00	0,00	58	162,50	8,85	21,20
3	38,75	0,00	0,05	59	164,75	9,35	22,30
4	41,00	0,02	0,09	60	167,00	9,95	23,70
5	43,25	0,02	0,12	61	169,25	10,40	24,80
6	45,50	0,05	0,18	62	171,50	11,00	26,10
7	47,75	0,07	0,25	63	173,75	11,70	27,40
8	50,00	0,10	0,32	64	176,00	12,40	28,90
9	52,25	0,12	0,38	65	178,25	13,20	30,60
10	54,50	0,15	0,45	66	180,50	13,80	32,00
11	56,75	0,18	0,50	67	182,75	14,50	33,50
12	59,00	0,22	0,62	68	185,00	15,25	35,10
13	61,25	0,27	0,72	69	187,25	16,10	37,20
14	63,50	0,30	0,82	70	189,50	16,90	39,40
15	65,75	0,35	0,93	71	191,75	17,80	41,30
16	68,00	0,40	1,02	72	194,00	18,70	43,50
17	70,25	0,45	1,12	73	196,25	19,50	46,00
18	72,50	0,52	1,25	74	198,50	20,60	48,10
19	74,75	0,58	1,38	75	200,75	21,75	50,20
20	77,00	0,65	1,52	76	203,00	22,90	52,60
21	79,25	0,75	1,65	77	205,25	24,15	55,30
22	81,50	0,82	1,80	78	207,50	25,50	57,90
23	83,75	0,90	1,95	79	209,75	26,67	61,00
24	86,00	0,97	2,10	80	212,00	28,00	63,80
25	88,25	1,05	2,32	81	214,25	29,60	66,90
26	90,50	1,12	2,52	82	216,50	31,30	69,80
27	92,75	1,22	2,75	83	218,75	33,00	73,40
28	95,00	1,32	2,95	84	221,00	34,60	76,30
29	97,25	1,42	3,20	85	223,25	36,45	79,60
30	99,50	1,52	3,40	86	225,50	38,10	83,60
31	101,75	1,65	3,70	87	227,75	40,00	87,10
32	104,00	1,78	4,00	88	230,00	42,20	90,80
33	106,25	1,90	4,30	89	232,25	44,30	95,00
34	108,50	2,00	4,60	90	234,50	46,40	98,00
35	110,75	2,15	4,95	91	236,75	48,40	
36	113,00	2,27	5,28	92	239,00	50,50	
37	115,25	2,45	5,55	93	241,25	53,00	
38	117,50	2,57	6,00	94	243,50	55,30	
39	119,75	2,75	6,45	95	245,75	57,80	
40	122,00	2,92	6,90	96	248,00	60,50	
41	124,25	3,10	7,35	97	250,25	63,40	
42	126,50	3,27	7,82	98	252,50	66,20	
43	128,75	3,47	8,37	99	254,75	69,00	
44	131,00	3,70	8,92	100	257,00	71,80	
45	133,25	3,95	9,48	101	259,25	75,00	
46	135,50	4,25	10,15	102	261,50	78,20	
47	137,75	4,45	10,80	103	263,75	81,00	
48	140,00	4,75	11,50	104	266,00	84,00	
49	142,25	5,00	12,20	105	268,25	86,80	
50	144,50	5,35	12,85	106	270,50	89,00	
51	146,75	5,70	13,75	107	272,75	91,30	
52	149,00	6,05	14,60	108	275,00	93,50	
53	151,25	6,50	15,50	109	277,25	95,60	
54	153,50	6,90	16,40	110	279,50	98,00	
55	155,75	7,32	17,65				

IV. *An Analysis of the Waters of two Mineral Springs at Lemington Priors, near Warwick; including Experiments tending to elucidate the Origin of the Muriatic Acid.* By WILLIAM LAMBE, M. A. late Fellow of St. John's College, Cambridge. From the Memoirs of the Literary and Philosophical Society of Manchester, Vol. V. Part I.

[Concluded from p. 269.]

XI. FURTHER PROPERTIES OF THE OXYGENATED MURIAT OF IRON.

THE facts I have related are unquestionable: it was in the latter end of 1795 that I first made the observation on the effect of hepatized water upon iron: since then I have verified it repeatedly, and particularly in the month of December 1796, with some very pure iron, and in the presence of two gentlemen, very competent judges, one of whom assisted at every part of the process. Still it has been asked, How is it possible that this solution can contain muriatic acid, seeing that nitrat of silver, that most delicate test of this acid, is hardly affected by it? To this it might perhaps be a sufficient reply, that it is unreasonable to oppose a mere analogy to the direct evidence of the senses; particularly in a new case, where we have found some of the analogies best established in chemistry to fail. But let us recur once more to experiment.

I formed again some oxygenated muriat of iron. I suffered the acid to remain on the oxyde about 24 hours; then poured off the liquor, and evaporated the salt to dryness to expell the superfluous acid: the salt, which deliquesces instantly on cooling, was re-dissolved in a little distilled water. 1. I tried the solution with the acetite of lead: not the smallest cloud was produced. 2. The solution was then tried with the nitrat of silver: a little white curdy matter was formed. 3. A tea-spoonful of the solution was diffused through two or three ounces of distilled water, and then tried with the nitrat of silver: a very slight cloud was formed, and a minute purple precipitate fell, but not till after some hours. The appearance

ance was not so strong, nor the precipitate so copious, as when nitrat of silver is dropped into ordinary rain water.— These experiments evince, that this salt either does not decompose the salts of lead and silver, or that the new compounds are soluble in water. The first is absolutely conclusive: as to the small appearance of decomposition in Exp. 2 and 3, be it considered how difficult it is to prevent a minute quantity of common acid from passing over in the distillation of the oxygenated acid; and how readily this acid itself is decomposed: add to this the imperfect oxydation, perhaps, of the iron. If these circumstances are duly weighed, it seems probable, that this salt, when quite pure, would not at all sensibly decompose nitrat of silver. A slight impurity cannot be detected by acetite of lead, as a small quantity of muriat of lead is soluble in water.

XII. FURTHER CONSIDERATIONS ON THE HEPATISED SOLUTIONS.

Besides the oxygenated salts, I think it probable, that these solutions retain some sulphur; but under what form, or in what combination, it is not easy to say. The residuum, after evaporation, has a peculiar smell, whereas the pure salts are inodorous. The stain left upon silver by the residuum ought, perhaps, to be attributed to this cause. Also, the white matter formed by the decomposition of oxygenated muriat of mercury seems to be a combination of sulphur and mercury. In proof of this it may be remarked, that the precipitate of this salt dissolved in simple hepatised water is white. Further, it is doubtless true, that if hepatised water have a small quantity of acid mixed with it, the solution of iron strikes a purple colour with galls. To point out the origin of this colour, mix iron filings and sulphur not washed, and form them into a paste with a little water, and let them remain together for some hours: put the paste into water, and filtrate: this water now strikes a purple colour
with

with galls. Now, common sulphur is always contaminated with a little sulphuric acid; and, as neither hepatic gas nor oxygenated salt is here concerned, the effect must be attributed to the acid and the sulphur. If this water be evaporated, it leaves a matter which does not deliquesce; but which emits the same smell as the residuum of the hepatic solutions. To shew that the acid is necessary to the production of the purple colour, let the sulphur be well washed with distilled water before it is mixed with the iron; and it will be found that no such colour can be now produced. The following fact seems to prove that sulphur may be retained in water, in the form neither of sulphur nor of hepatic gas: it is an additional proof how essentially the oxygenated differs from all the common salts of iron. I saturated a diluted solution of oxygenated muriat of iron, which scarcely affected nitrat of silver, with hepatic gas. A white precipitate fell, but so minute that it was impossible to collect it, nor did it destroy the transparency of the water: hence I think it probable that, if the salt were quite perfect, it would not be sensibly affected by hepatic gas. I now boiled the liquor, to expell the gas, till it wholly lost its hepatic smell. The liquor was again tried with nitrat of silver; and there was a copious deposition, but of a dark brownish colour. It seems certain, then, that some sulphur is retained by the solution, which cannot be expelled by boiling.

XIII. THE NEUTRAL SALTS OF THE WATER: MURIAT OF MAGNESIA, MURIAT OF SODA, SULPHAT OF SODA.

A gallon of the water was evaporated to dryness; the deliquescent salts were separated from the non-deliquescent; and each of the salts which were thus obtained was carefully examined. Thus, by processes which are sufficiently known, it was found that the gallon of water contains of muriat of magnesia 11.5 grains nearly; muriat of soda 430 grains; sulphat of soda 152 grains.

The

The triple compound of which I have treated, is mixed with the deliquescent salt of magnesia, but not wholly; for it may be discovered with the non-deliquescent salts, though these have been separated carefully by spirit of wine. The tartrate of potash indicates it in both. Oxalic acid does the same thing, separating a white powder with some crystalline grains which are the oxalat of manganese. (See Bergman, *Dissert. viii. 24.*)

XIV. THE RESIDUUM OF DIFFICULT SOLUTION.

After these salts had been separated there remained a large residuum, which was not soluble except in a great quantity of water. This has a crystalline form like sulphat of lime; and the usual reagents shewed it, in fact, to contain both lime and sulphuric acid. But the weight of this residuum, from a gallon of water, was no less than 112 grains: a larger quantity than could be dissolved in a gallon of water, if it were pure sulphat of lime. If it be considered that the water requires some evaporation before these crystals begin to separate, the proportion is still more increased. There must be, therefore, something peculiar in the composition of the salt, or in the soluble powers of the water. Other experiments shew the same thing. 1. Sulphuric acid dropped into the water precipitates copiously sulphat of lime. This cannot be effected by the decomposition of the muriat of lime; since we have already seen that no such salt is to be found (XIII.). Indeed it cannot exist in the same solution with sulphat of soda, as these salts decompose each other*. 2. Sometimes a more unexpected appearance than this

* It is astonishing that this fact should have been neglected, and that in recent publications. Mr. Schmeisser, in his analysis of the waters of Kilburn Wells (*Phil. Transac.*), has joined together sulphat of soda, sulphat of magnesia, and muriat of lime, as being contained in these waters. Dr. Garnett has also put into the composition of the sulphur-well at Harrowgate sulphat of magnesia and muriat of lime; an error the more unaccountable, as Bergman has expressly remarked this decomposition in his *Dissertation on the Analysis of Waters*. See *Dissert. ii. 7. M.*

takes place. It is, that a precipitate, seemingly like the former, has been made by the addition of the muriatic acid: but by the addition of more acid the precipitate is re-dissolved. Sometimes, indeed most commonly, I have not been able to effect this appearance.

It was natural to expect the solution of any further uncommon observation in the same matter that had already explained so much. 3. I accordingly digested sulphat of lime in the hepatised solutions of iron and manganese; and I found that the latter had a very strong solvent power. After the liquor had been filtered, sulphat of lime was plentifully precipitated by sulphuric acid. The solution of iron seems to have something of a similar property; but as it is very small, and as iron has almost always a little manganese united with it, it is at least uncertain whether the whole effect ought not to be attributed to manganese.

It remains to compare this remark with the effects of the artificial oxygenated salts; and thus to confirm, if confirmation were needed, the analogy which I have laboured to establish. 4. Sulphat of lime was digested with the oxygenated muriat of manganese and distilled water by a gentle heat: after 24 hours the clear liquor was separated: into this I dropped a little sulphuric acid; by degrees a large quantity of sulphat of lime was separated. Muriatic acid was dropped into the same liquor, but it did not separate any thing. The oxygenated muriat of iron possessed the same property, but in so small a degree, that here again I am inclined to attribute this power to a little manganese attached to the iron. It follows from these facts, that the large quantity of sulphat of lime is kept in solution by the salt of manganese. And a further examination of the residuum itself shews that it contains the triple salt of manganese and iron. 5. Some of the residuum was perfectlyedulcorated, and sulphuric acid was dropped upon it; the vapours of muriatic acid arose, and were rendered evident by paper moistened with ammoniac or with simple water. To the sulphuric acid,

acid, which was used in this experiment, was added some distilled water, and the liquor was filtrated: it was then saturated with an alkali; a small precipitate fell, which was proved (by the usual methods) to contain both manganese and iron.

6. I have noticed a variation (2.) in the effect of muriatic acid when added to the water. I have observed a similar variety in the residuum itself; which is, that sometimes it has been found soluble in the muriatic acid: when this happens, the addition of an alkali precipitates the residuum in its original crystalline form; and this it does before the acid is saturated. But most commonly the muriatic acid does not dissolve it at all. Further, it has been said above (VII. I.) that the acids precipitate a crystalline substance from oxygenated muriat of iron. This substance I have found to contain manganese. But what belongs to this place to observe is, that it is not always, indeed it is but rarely, that this effect can be produced in any great degree: in a very small degree it may always be observed; but, when I first remarked it, the precipitate was very copious, so that enough was readily collected for examination by the blow-pipe. The salt of manganese does not shew this appearance in the smallest degree. It depends, therefore, on some peculiarity of the iron rust, but precisely on what I cannot take upon me to determine.

As the oxygenated salts unite with all the other salts of the water, and consequently cannot be separated by spirit of wine, I have found it impossible to determine the quantity of them.

I had concluded from the experiment (I.) that this water contained muriat of lime; and the following remark confirmed me in my error: I mention it, as I think it probable that others have been led into mistakes from the same cause. I reduced some of the water, by evaporation, to about two ounce-measures; taking for granted that by this process

nearly the whole of the sulphat of lime was separated. By adding sulphuric acid to this liquor, 20 grains of sulphat of lime were precipitated. I concluded, therefore, that this must have proceeded from the decomposition of muriat of lime: in truth, this sulphat was dissolved in the two ounce-measures of water, and was separated by the decomposition of the oxygenated salt.

ON THE WATER OF THE OLD BATHS.

THE spring which supplies these baths was discovered in 1786, in which year a cold and a warm bath were constructed. Upon sinking the well, a rock was found at the depth of eighteen feet; and the water rises from about the depth of three feet within the rock.

XV. THE GASEOUS FLUIDS.

I could obtain very little gas from this water, not more than three cubic inches from a gallon. It was azotic. An hepatic smell is perceptible when the water is fresh. To the hepatic gas, doubtless, it is owing, that no oxygen is found in this water or in that of the other spring. Dr. Garnett has so well explained the cause of this circumstance, that it is needless for me to enter upon it. (See Dr. G. on the Mineral Waters of Harrowgate, p. 74, &c.)

XVI. THE SPONTANEOUS PRECIPITATE.

This water is pellucid when it first rises from the spring; in small quantities it does not lose its transparency: a very small sediment is deposited by boiling, so small indeed that sufficient cannot be collected in this way for examination. However, when the bath has been newly filled, in some hours the transparency of this large body of water is destroyed by exposure to the atmosphere, and it contracts a whitish colour. I collected a large quantity of this precipitate from the bottom of the bath, where it by degrees accumulates. I first attempted its analysis by acids, but was disappointed. It is hardly soluble

In any of the mineral acids: they all take up a little of it, make a brisk effervescence, and excite heat when first applied; but neither by a long digestion, nor by boiling, could I saturate the acids; nor, by putting a very small quantity of the powder into a large quantity of acid, could I completely dissolve the powder.

2. But by the use of the blow-pipe it readily appeared that this sediment is no other than the oxydes of the two metals so frequently mentioned, iron and manganese. It may be made magnetic; it gives the hyacinthine colour to borax; the colour is destroyed by continuing the fusion, and may be renewed by removing the globule to a silver spoon: fused with soda and nitre it makes a blue or a green globule. As the sediment may be procured in sufficient quantity, I repeated the last experiment on a larger scale: some nitre being mixed with it, the mass was pulverised, and fused in a crucible; when taken out of the fire it was green, and dissolved in water, to which also it imparted a fine green colour: in a day or two a yellow ochre was deposited, when the solution became blue; from this liquor a powder sublimed by exposure to the air, which was manganese. (See Scheele's Essay on Mang. xxxvi. B.)

3. Pursuing the observations of the effects of the mineral acids confirms this conclusion. I mixed some of the sediment with powdered charcoal, and exposed the mixture to a strong red heat: it became of a light brown colour, and now proved to be readily soluble in all the mineral acids. (See Scheele's Essay on Manganese, xxxviii. A.) With the muriatic and nitric it formed a gelatinous compound. The sulphuric acid, diluted, was soon saturated; the liquor was evaporated, and deposited white crystals, the form of which is rhomboidal. This is a triple salt, the base of which is iron and manganese. If there be a small excess of acid, the taste is very like that of sulphat of argill. The same salt may be obtained by boiling the sulphuric acid with the sediment itself, and continuing the boiling till the mass is be-

come dry: the salt may then be procured by lixiviating the dry mass, and crystallising the solution.

XVII.

Neither fulphat of argill nor oxygenated muriat of mercury is at all decomposed by this water.

XVIII. THE METALLIC SALTS.

All the appearances which demonstrate the existence of peculiar metallic salts in the waters of the new baths are also to be found in this: as, the oxydation and solution of metals and a copious precipitate by galls, while the prussiat of potash is not affected (IV.): and the same experiments were repeated to shew the presence of the oxygenated salts of iron and manganese (V. VII. &c.) with the same result, and authorise the same conclusions. Still I believe there is some difference in regard to these salts between the two waters. 1. I have already observed (XVII.) two points of distinction; and, as the second of those experiments is probably an indication of sulphur, this water seems to be without it. This is confirmed by evaporating the water in a silver vessel, to which it communicates no stain. However, 2. Its action on copper is very strong, so that, if it be boiled in a copper vessel for a long time, a blue oxyd of copper is separated from the vessel. But here, again, there is a difference between this and the former water; for, though copper is dissolved in it, none can be precipitated on iron in its metallic form, as we have seen (IV. 1.). The iron in this water does not seem to be in that high degree of oxygenation that it is in the other. This I infer, because, 3. the precipitate formed by tincture of galls is of a much darker colour, even when the water has been much evaporated; sometimes, when the water has been reduced to half its original bulk, I have remarked even a very slight green tinge communicated by prussiat of potash, but not till it has been added to it many hours.

As the oxygenated salts are formed by the action of hepatic gas on the metals, it cannot be doubted that they are very common. Bergman (*Differt.* vii. 6.) observes, "that cold martial waters, when fresh, almost always have an hepatic smell:" it seems very probable then that this salt of iron may be found in almost all such waters. I doubt not that it has been frequently mistaken for muriat of lime, to which in its properties it approaches very nearly.

Though I have purposely avoided all medical discussion in this essay, I cannot abstain from bestowing a moment's consideration on one very obvious question. What, it will be asked, are the medical properties of manganese? Is it useful? Is it innocent? Is it noxious? That it is innoxious I certainly know. Dr. John Johnstone (*Essay on Mineral Poisons*, page 134.) has shewn that it may be taken in large doses without injury; and he has informed me, that he has since confirmed the same fact frequently. I wish I could as well answer the first question; but what the medical virtues of this substance may be, is a subject which still remains in a great measure unexplored. It is certainly well worth the attention of men of science. To those who are inclined to labour in this field I take leave to suggest, that they should use either the carbonat or some other salt of manganese: the black oxyde, I apprehend, must be hardly soluble in the human fluids.

XIX. THE NEUTRAL SALTS.

These are the same as of the other water, but in different quantities. The gallon contains of muriat of magnesia 58;—muriat of soda 330;—sulphat of soda 62 grains.

XX. THE RESIDUUM.

A still larger residuum is obtained, after the separation of the neutral salts, from this than from the other water. The gallon leaves 146 grains. Its properties are the same as of that already described (xiv.).

It is to be observed, that both these springs are affected by rainy weather; and that, consequently, their contents vary considerably according to the seasons.

SYNOPTICAL TABLE OF SUBSTANCES CONTAINED IN
THE TWO SPRINGS.

Gaseous fluids contained in a wine-gallon in cubic inches.

	WATER OF THE NEW BATH.	WATER OF THE OLD BATH.
Hepatic gas - - -	too small to be measured.	too small to be measured.
Azotic gas - - -	3.5	3
Carbonic acid gas - -	.5	

Solid contents of a wine-gallon in grains.

Carbonat of iron - -	.75	
Oxyds of iron and man- ganese - - -		too small to be weighed,
Oxygenated muriat of iron and manganese	unknown, but very small.	unknown, but very small.
Sulphur - - -	unknown, but very small.	
Muriat of magnesia -	11.5	58
Muriat of soda - -	430	330
Sulphat of soda - -	152	62
Sulphat of lime - -	112	146

Extract of a letter from Dr. HOLME, dated Sept. 25th 1797.

"In the analysis of the waters of the new baths I have conjectured that the decomposition of oxygenated muriat of mercury is occasioned by a minute portion of sulphur, attached to some of the substances dissolved in the water (III.). I have attempted to verify this conjecture, and not without success. Wishing to collect some quantity of the precipitate, I evaporated a gallon of the water to half its bulk; but found, that now the salt of mercury was dissolved without decomposition. I added, therefore, the salt to the water without boiling; and suffered the precipitate to subside. By this process, I could collect no more than a grain from a gallon of water. I threw this upon alkali heated to redness; but

the

the whole instantly evaporated with a dense smoke. I mixed, therefore, another portion (procured in the same manner) with alkali, and heated them in a crucible: still I failed to collect any sulphur from the alkali (as I had hoped); but I now perceived that, as the crucible became hot, the matter burnt away with a blue flame, as sulphur does.

“Sulphat of argill is not decomposed by this water when it has been reduced by evaporation: however, it gradually separates some of the abundant sulphat of lime; which is probably caused by its attracting the water which held it in solution.

“I think it right here to observe, that I have recently met with this water in such a condition that it caused a permanent decomposition of sulphat of argill. This precipitate is extremely minute: I have not as yet determined the cause of it, but I suspect it to be carbonat of magnesia.”

V. *Second Memoir on the Metal contained in the Red Lead of Siberia.* By Cit. VAUQUELIN. From the *Annales de Chimie*, Vol. XXV. 1798.

I HAVE already shewn in my first memoir * on the red lead of Siberia, that this mineral contains a particular metal, which I promised to examine with more attention. The Council of Mines having furnished me with a pretty large quantity of the red lead, considering its scarcity, I have been able to make a series of experiments sufficient to determine its principal properties, of which I shall now give an account; but it will first be necessary to recapitulate, in a few words, the substance of my former memoir, in order that what I have to say at present may be rendered more intelligible.

1. I shall observe, that on boiling the red lead reduced to a powder with two parts of the carbonat of potash, the lead

* See page 279.

combined itself with the acid of the carbonat; and that the alkali was afterwards united with a particular acid, which gave it an orange-yellow colour, and the property of producing crystals of the same colour.

2. That this new combination was decomposed by mineral acids; and that on causing the liquor, in which the decomposition had been effected, to evaporate, there was obtained, on the one hand, the salt formed by the mineral acid which had been added; and on the other, the acid of the red lead, under the form of elongated prisms of a ruby colour.

3. That the combination of the acid of the red lead with potash formed, with the nitrat of mercury, a precipitate of a cinnabar red colour; with the nitrat of lead, an orange-yellow sediment; with the nitrat of copper, a precipitate of a chestnut-red, &c.

4. That this acid alone became green by the contact of light, by a solution of tin and of the greater part of metals.

5. That the same acid, either free or in a state of combination, combined itself with borax, microcosmic salt, and glass; and communicated to them a beautiful emerald-green colour.

Such, in a few words, are the principal properties of the acid of the new metal contained in the red lead, as announced in my first memoir. I shall now proceed to examine the other characterising marks of this substance; and shall enlarge chiefly on those which ought to make us consider it as a particular metal, and on those which distinguish it from other bodies of the same class.

EXP. I. *Action of Acids on the Red Lead.*

If one part of the muriatic acid, mixed with as much water, be poured over the red lead, reduced to powder, there will be formed muriat of lead, which deposits itself under the form of white crystals, and the liquor assumes a very beautiful orange colour.

In this operation the muriatic acid, as is evident, combines with it in virtue of a greater affinity to the lead, from which it separates the natural acid, which is then dissolved in the water of the muriatic acid. When suitable proportions of the acid, water, and lead have been employed, if the liquor be evaporated by a gentle heat and without the contact of light, you may obtain crystals of the acid of a ruby red colour. But if too great a quantity of the acid be used, or an acid too much concentrated; and, above all, if heat has been employed in the process; instead of a red acid, you will obtain a dark green liquor, which is then a combination of the oxyde of the new metal with the muriatic acid. It will be seen hereafter what are the causes of these essential differences: at present it is sufficient to mention them.

The sulphuric acid decomposes also the red lead, by laying hold of the oxyde; but I did not employ it to extract the acid, because, if ever so little a quantity more than is necessary be added, it is very difficult to separate it.

The nitric acid does not produce any change in the nature of the red lead, only that when aided by the action of heat it effects its solution; but on cooling, the greater part of the red lead separates itself with all its properties.

EXP. II. *Action of Alkalies on the Red Lead.*

Caustic alkalies do not seem to decompose the red lead, for they dissolve it entirely, and form with it a kind of triple combination; the properties of which I did not examine minutely.

Alkaline carbonats, on the contrary, decompose the red lead completely; and there is formed, on the one hand, carbonat of lead; and on the other, a soluble salt composed of the metallic acid and of the base of the carbonat employed.

The salts formed by this acid with alkalies crystallise into prisms, or into laminæ of a golden yellow colour, the forms
of

of which I have not been able to determine accurately, on account of the small quantity I could make.

These salts have a slight metallic taste: they dissolve with effervescence, and assume a green colour: they are decomposed by acids and alkaline earths, which form orange yellow precipitates.

EXP. III. *Action of Acids on the Acid of the Red Lead.*

Among the mineral acids, the muriatic is the only one which acts in a remarkable manner on that of the red lead. Indeed, whether the red lead be distilled, or its acid with the muriatic acid a little concentrated, there is soon disengaged oxygenated muriatic acid, and the liquor assumes a very beautiful green colour. The cause of this may be readily conceived: the muriatic acid takes from that of the lead a part of its oxygen, and reduces it to the state of a green oxyde, which is held in solution by another portion of the muriatic acid.

As this experiment announced to me that the oxygen does not adhere strongly to that metal, I was desirous to know whether its acid mixed with the muriatic acid would dissolve gold: I therefore put into this mixture a piece of gold leaf, which was dissolved in a little time by the help of a gentle heat, and the solution had a yellowish-green colour. This acid then produces the same effect as the nitric acid in aqua-regia, in regard to the solution of gold.

The sulphuric acid, cold, produces no effect upon this acid; but when warmed it makes it assume a bluish green colour, by favouring, no doubt, the disengagement of a portion of its oxygen, as it does in regard to the oxyde of manganese and the acids of tungsten and molybdena.

The sulphurous acid lays hold of a part of the oxygen of this acid, becomes sulphuric acid, and reduces that of the lead to the state of an oxyde, which it dissolves.

EXP. IV. *Reduction of the Oxyde of the Red Lead.*

An experiment which could not but excite my curiosity was, to know whether the acid of the red lead, treated in a suitable manner, could be reduced to a metallic state. For this purpose I put 72 parts of this acid, extracted by the muriatic acid in the manner before mentioned, into a crucible of charcoal, which I placed in another crucible of earth filled with charcoal dust. Having then heated it for half an hour in a forge fire, I found in the charcoal crucible a metallic mass of a whitish grey colour, in the form of needles interwoven through each other, and which weighed 24 parts. The result of this operation shews that the acid of the red lead contains a large quantity of oxygen, since of 72 parts employed, 24 only, which make one third, were converted into metal.

EXP. V. *Properties of the Metal.*

The small masses with which I was obliged to make my experiments did not allow me to discover a great number of properties in this metal. The few, however, which I observed are sufficient to characterise it, and to induce me to assign it a particular place among the metallic substances.

1. It is white, greyish, exceedingly brittle, infusible, fixed and crystallised into needles.

2. Exposed to the heat of the blow-pipe it becomes covered with a lilac-coloured crust, which, on cooling, turns green.

3. Heated by the same apparatus with borax it does not melt; but a part after being oxydated dissolves in that salt, and communicates to it a very beautiful green colour.

4. The action of acids upon it is exceedingly weak. The nitric acid is the only one which makes it undergo any remarkable change. By distilling five or six times successively to dryness 20 parts of this acid, concentrated, upon one of the metal, I was able to convert it into an orange yellow powder, which at first was green.

This

This powder is acid; dissolves in water; combines itself with alkalies, from which it disengages the carbonic acid and precipitates metallic solutions, exactly with the same phenomena as the acid of the natural red lead. It therefore appears to me, beyond a doubt, that I have made here, in every respect, the particular acid, such as it exists in the red lead of which it forms one of the elements.

My experiments, and the phenomena they gave rise to, as mentioned in this memoir, authorise me to consider the substance which mineralises the lead in the red lead of Siberia not only as a metal, but as a particular metal, which, with the general properties of the metals already known, possesses very distinct characterising marks that belong to no other. What metallic substance, indeed, is there, which, converting itself into an acid of a ruby red colour, has the property, in that state, of becoming green by the light, by caloric and metallic substances, and of precipitating the nitrate of mercury of a cinnabar red colour; lead of an orange yellow colour; nitrate of copper of a chestnut red colour; of dissolving gold conjointly with the muriatic acid; of precipitating the tanning principle of a brown colour, and alkaline prussiate green? Without doubt there is none.

On account of these properties, and by the advice of Cit. Fourcroy and Haüy, I propose to call this metal *échrome*, which signifies colour; because its combinations are, indeed, all more or less coloured. I however must confess that this appellation is not suited to the metal itself, since it has no particular colour; and that, besides, each metal has one peculiar to itself, more or less different. I am not, therefore, attached to this name more than to any other that may be given it, provided it expresses any of its most striking and most characteristic qualities.

The brittleness and infusibility of this metal do not give us reason to think that it can be applied to very many useful purposes; but we may still hope that, if it can be found hereafter in larger quantities, the combinations of its acid

with metallic oxydes, and of its oxyde with vitreous substances, will furnish very beautiful and durable colours for the art of painting and enamelling. This hope appears to me so much better founded, as I have already discovered the oxyde of this metal in the emerald, in which it forms the colouring principle. I have also found it in the matrix of the red lead, in the state of a green oxyde combined with the lead; and I have no doubt that it may be found in many other combinations, when minerals shall be examined with more care than they have hitherto been.

It results then that *chrome* is a peculiar metal before unknown; that this metal, infusible and crystallisable, has little affinity with oxygen, from which it derives however two thirds of its weight; that this acid of a red colour dissolves in water and combines with alkalies, earths and metals, to which it communicates different colours, but more or less analogous to its own; that it readily loses a part of its oxygen either by light, caloric, or the contact of certain metals, and the greater part of combustible substances, by passing through all these circumstances to the state of a green oxyde; and hence it is that this acid and all its combinations yield, by heat, a certain quantity of oxygen, and communicate to glass a beautiful green colour.

VI. *Proposal for a new Hygrometer. By Mr. HOCHHEIMER.*
From Economische Hefte.

VARIOUS hygrometers have been invented, but they are all in some degree imperfect: 1st, because they do not determine with accuracy in what proportion water is dissolved in the atmosphere; and 2dly, because they do not suffer the moisture they have imbibed to escape from them in the same proportion as that in which they attracted it. I shall, therefore, mention in a brief manner only a few of them, and then propose a new method of constructing a hygrometer; though I must, at the same time, remark, that I by no means offer

it as a perfect and complete instrument. I wish merely to communicate my ideas on the subject, and to give others an opportunity of examining it farther, and of perhaps producing something that may be better calculated to answer the intended purpose. It is, indeed, much to be wished, that an accurate hygrometer could be invented; as it may be readily conceived that such an instrument would be of the utmost utility, not only to naturalists, but also to farmers and others.

The most common hygrometer, known under the name of a weather-house, is founded on the property of several twisted substances to untwist themselves in a moist atmosphere, and then to twist themselves back when the weather is dry. The substances chiefly employed are cat-gut; and, when required on a large scale, hempen ropes. Cassébois, a Benedictine monk, at Metz, proposed another hygrometer, which consists of the gut of a silk-worm. When that insect is ready to spin, there are found in it two vessels proceeding from the head to the stomach, to which they adhere, and then bend towards the back, where they form a great many folds. The part of these vessels next the stomach is of a cylindric form, and about a line in diameter. These vessels contain a gummy sort of matter from which the worm spins its silk; and, though they are exceedingly tender, means have been devised to extract them from the insect, and to prepare them for the above purpose. When the worm is about to spin, it is thrown into vinegar, and suffered to remain there twenty-four hours; during which time the vinegar is absorbed into the body of the insect, and coagulates its juices. The worm being then opened, both the vessels, which have now acquired strength, are extracted; and, on account of their pliability, are capable of considerable extension. That they may not, however, become too weak, they are stretched only to the length of about fifteen or twenty inches. It is obvious that they must be kept sufficiently extended till they are completely dry. Before they attain to that state they must be freed, by means of the nail of the finger, from a slimy substance which
adheres

adheres to them. Such a thread will sustain a weight of six pounds without breaking; and may be used for an hygrometer in the same manner as cat-gut. Paper, parchment, wood, ivory, hair, and the beard of wild oats, &c. have been employed for hygrometers on the same principle.

Another sort of hygrometer is founded on the increase of weight which certain bodies acquire by the moisture they attract from the atmosphere. Thus, for example, if a sponge which has been dipped in a solution of sal ammoniac, and again dried, be suspended in the open air at the end of a balance, the variation of its gravity marked by a weight placed at the other end will shew the temperature of the atmosphere in regard to drought and moisture.

Mr. Lowitz found at Dmitriewfsk in Astracan, on the banks of the Wolga, a thin blueish kind of slate which attracted moisture remarkably soon, but again suffered it as soon to escape. A plate of this slate weighed, when brought to a red heat, 175 grains, and, when saturated with water, 247: it had therefore imbibed, between complete dryness and the point of complete moisture, 72 grains of water. Lowitz suspended a round thin plate of this slate at the end of a very delicate balance, fastened within a wooden frame, and suspended at the other arm a chain of silver wire, the end of which was made fast to a sliding nut that moved up and down in a small groove on the edge of one side of the frame. He determined, by trial, the position of the nut when the balance was in equilibrio and when it had ten degrees of over-weight, and divided the space between these two points into ten equal parts, adding such a number more of these parts as might be necessary. When the stone was suspended from the one arm of the balance, and at the other a weight equal to 175 grains, or the weight of the stone when perfectly dry, the nut in the groove shewed the excess of weight in grains when it and the chain were so adjusted that the balance stood in equilibrio. A particular apparatus on the same principles as a vernier, applied to the nut, shewed the

excess of weight to ten parts of a grain. Lowitz remarked that this hygrometer in continued wet weather gave a moisture of more than 55 grains, and in a continued heat of 113 degrees of Fahrenheit only $1\frac{1}{2}$ degree of moisture.

In my opinion, it would not be necessary, in order to construct such a hygrometer, to procure argillaceous slate from Astracan, as several other argillaceous kinds of slate, as well as stones and other substances, possess in an equal degree the same property. If a person, for example, presses with the finger on a marble slab, a grey free-stone or a piece of glass, it will immediately attract the insensible perspiration, and become tarnished.

The hygrometer thus invented by Lowitz was however attended with this fault, that it never threw off the moisture in the same degree as the atmosphere became drier. It was also sometimes very deceitful, and announced moisture when it ought to have indicated that dryness had again begun to take place in the atmosphere. To avoid these inconveniencies, I would propose the following method :

1. Take a square bar of steel about two lines in thickness, and from ten to twelve inches in length, and form it into a kind of balance, one arm of which ends in a screw. On this screw let there be screwed a leaden bullet of a proper weight, instead of the common weights that are suspended.

2. Take a glass plate about ten inches long and seven inches in breadth, destroy its polish on both sides, free it from all moisture by rubbing it over with warm ashes, suspend it at the other end of the balance, and bring the balance into equilibrium by screwing up or down the leaden bullet.

3. Mark now the place to which the leaden bullet is brought by the screw, as accurately as possible, for the point of the greatest dryness.

4. Then take away the glass-plate from the balance, dip it completely in water, give it a shake that the drops may run off from it, and wipe them carefully from the edge.

5. Apply

5. Apply the glass-plate thus moistened again to the balance, and bring the latter into equilibrium by screwing the leaden bullet. Mark then the place at which the bullet stands, as the highest degree of moisture.

6. This apparatus is to be suspended in a small box of well-dried wood*, sufficiently large to suffer the glass-plate to move up and down. An opening must be made in the lid, exactly of such a size as to allow the tongue of the balance to move freely. Parallel to the tongue apply a graduated circle, divided into a number of degrees at pleasure from the highest point of dryness to the highest degree of moisture. The box must be pierced with small holes on all the four sides, to give a free passage to the air; and to prevent moisture from penetrating into the wood by rain, when it may be requisite to expose it at a window, it must either be lathered or painted. To save it at all times from rain, it may be covered, however, with a sort of roof fitted to it in the most convenient manner. But all these external appendages may be improved or altered as may be found necessary.

VII. *Method employed in Spain for making the Alcarrazas, or Vessels used there for cooling Water. By Cit. LASTETRIE. From the Journal des Mines, No. XXXIV. 1798.*

ALCARRAZAS are a kind of vessels used in Spain for cooling water intended for drinking. As they are exceedingly porous, the water oozes through them on all sides; the air which comes in contact with it, by making it evaporate, carries off the caloric contained in the water in the vessel, and by these means renders it remarkably cool†.

These

* We would recommend a glass case. EDIT.

† It is a principle, universally admitted, that a liquid, passing to a state of vapour, appropriates to itself a quantity of caloric, which it takes from those bodies with which it is in contact. The more volatile a liquid is, the more rapid will be this effect; and it is on this principle that che-

These vessels, which are of different forms and sizes, are manufactured in various parts of Spain, and are generally of a greyish white colour. The most celebrated place for this species of pottery, and that from which all the vessels of this kind used at Madrid are brought, is Anduxar in Andalusia. The earth employed for making them is procured on the banks of a rivulet called Tamuforo, which is situated at the distance of a quarter of a league from the above town.

The use of these vases was introduced into Spain by the Arabs. They are still used in Egypt, as well as in different parts of Africa; and are known in the East Indies, Syria, Persia, China, and other parts of Asia.

It is astonishing that these vases were never introduced by the Arabs into Sicily. I never saw any of them in any part of that island. This singular fact proves, that the simplest and most beneficial usages are rarely imitated by

mists, during the heats of summer, cause, in some minutes, the congelation of water inclosed in a small glass ball covered with a cloth dipped in ether, care being taken to renew it in proportion as it evaporates. It is well known that coldness may be effected by liquors much less volatile than ether, either by exposing the vase, the surface of which has been moistened with them, to a current of air, or by swinging it round a point of suspension, which by moving it through the air serves to favour the solution of the vapour in the atmosphere. From these principles it will be readily conceived on what depends the property of the alcarrazas above mentioned. On being exposed to the open air, or rather to a current of air, the water they contain becomes cool in a little time, and to such a sensible degree, that in summer, when the thermometer stood at $99\frac{1}{2}^{\circ}$ F. in the shade, at Madrid, the water has been known to descend to the temperature of water preserved a considerable time in a cellar. These vases, however, cannot be long used, unless care be taken to fill them only with very pure water, and such as is little charged with the sulphat of lime (*selenite*). Turbid water soon closes up the pores even of filtering paper; and the same effect will be produced by water that holds in solution sulphat of lime, because the water abandons it in proportion as it unites with the air in a state of vapour. To open the pores, closed up by earthy salts, it will be sufficient to keep these vases for some moments in boiling water. EDIT.

other

other nations, unless recommended by some favourable incident.

Though France is so near to Spain, and though there has always been great intercourse between these two countries, no traveller has ever yet given an account of the process employed in the fabrication of the above vases. The introduction of them into France would, in my opinion, be attended with great advantage; for, besides the pleasure of drinking cool water during the great heats, we ought to take into consideration the benefit that would arise from them in regard to the health. I have, therefore, procured correct information respecting the manner in which these vases are made in Spain; and I have brought alcarrazas to France, as well as the earth employed in the fabrication of them.

Cit. Darcet was desirous of analysing this white marly earth; and, by employing all the precision necessary for that purpose, he found that 100 grains of it contained 60 of calcareous earth mixed with alumine and a little oxyd of iron difficult to be dissolved, and 36 $\frac{1}{2}$ of siliceous earth also mixed with alumine and the same oxyd*. The quantity of iron may be estimated at almost a grain. The process for fabricating the alcarrazas is very simple; and, as the earth employed abounds in France, it will be easy, by the method which I shall explain, to establish manufactories of this kind; the expences of which will be trifling, and the profits certain, if the public do not refuse to adopt a useful practice.

The preparation given to the earth may be reduced to three principal operations.

1st Preparation. Suppose it were necessary to manufacture 150 pounds of earth: after it has been dried, and divided into portions of the size of a walnut, it is macerated in a basin or tub, by proceeding in the following manner: The

* A French journal states the result of Cit. Darcet's analysis thus: "About one third part of calcareous earth; one third alumine; one third ~~lex~~-mixed with a very small portion of iron." EDIT.

workman takes three or four *celemins* of earth*, which are spread out equally in the bason, and water is poured over it; he then throws in three or four *celemins* more of earth, which are watered as before; and this operation is repeated until the tub be sufficiently full. In pouring on the last water, care is taken not to add more than may be necessary to cover the whole mass. The earth is suffered to remain in this state for twelve hours; after which it is worked and kneaded with the hands, in the tub, until it is reduced to the consistence of a tough paste. The earth is then deposited on a smooth platform covered with brick, kept exceedingly clean, and over which is strewed a little sifted ashes. It is formed into a cake about six inches in thickness, which is smoothed on the surface as well as at the sides. It is left in that state until it begins to crack; after which it is freed from the ashes adhering to it, and removed to another tiled place made exceedingly clean,

2d Preparation. To this earth the workman adds seven pounds of sea salt, if he wishes to make *jarras*, and only the half if it is destined for the fabrication of *botifas* or *cantaros*. This difference arises from the greater or less capacity intended to be given to the vases. The larger the vase is, its sides must be so much thicker, in order that it may have the necessary degree of strength; but the earth, at the same time, must be more porous, otherwise the water would not filter through with ease; and, for this reason, the workman adds a greater quantity of salt when he wishes to make *jarras*, which are much larger than the *botifas* and *cantaros*. The earth is kneaded with the feet, adding the salt gradually; and this labour is repeated, at least three times, without the necessity of adding more water, as the moisture retained by the earth is sufficient.

3d Preparation. The earth, after being subjected to these different preparations, is fit to be applied to the lath. The

* The *celemin* is a measure of capacity, which contains about seven pounds of grain.

man who is employed for this work ought to knead it well with his hands, taking care to extract the stones, even the smallest which he may meet with, as well as every other foreign body. He then forms it into lumps, which he applies to the lath to be made into vases or jars.

The alcarrazas may be baked in any kind of furnace used by potters. Those employed in Spain are eighteen feet square in the inside; and five feet three inches in height. The flame enters by a hole, one foot four inches in diameter, situated in the centre. Such a furnace will contain 800 pieces of different sizes, including 500 *jarras*. Pottery of much greater strength than the alcarrazas may be baked in the same furnace, if care be taken to keep up the fire for one or two hours longer. The alcarrazas, which require to be only half baked, remain there ten or twelve hours, according to the temperature of the air, or the greater or less quantity of fuel employed.

Processes different from that which I have here described, are pursued in some of the potteries in Spain; but they all depend on the same principles. After the earth has been pounded, it is suffered to macerate in a tub for twenty-four hours; the whole is stirred round with a stick, and it is freed from the straws or other foreign bodies that float on the surface. The stones and coarser parts of the earth fall to the bottom of the vessel, and the finer is drawn off by a hole four inches above it. The earth is then left to dry to a certain degree requisite; and it is afterwards deposited in a moist place, to be employed as may be found necessary. In other manufactories, the earth, when dry, is ground below a roller; after which it is sifted, and, the proper quantity of salt and water being added, it is then kneaded. The proportion of salt is not every where the same. In some places the same quantity of earth requires a half less of salt. Care is always taken to choose earth of a proper quality, without ever having occasion to add to it a mixture of sand. The same earth is employed also for common pottery; the only dif-

ference is, that salt is added to the clay used for the alcarrazas, and that they are only half baked.

There is not a single family in Madrid where these vessels are not used. They are filled with water, which is exposed for several hours to a current of air, in order that the evaporation may be more rapid, and that the water consequently may become cooler.

A kind of red vessels called *bucaros*, employed likewise to cool water, are made also at a place called Salvatierra in Estramadura; but the earth being less porous, it is not so proper for the intended purpose. Besides, these vases communicate to the water a disagreeable argillaceous taste. They are, however, in great request among the ladies of Madrid; some of whom pound fragments of them, and mix the powder with snuff. Young girls have a particular fondness for this kind of pottery, and eat it when they are troubled with the chlorosis.

Vases of a similar kind to those above described, are employed in Portugal for moistening snuff. They are plunged into water, after being filled with this article; and the water which filters insensibly through them communicates to it, at the end of some hours, the necessary degree of humidity.

VIII. *On the Theory of the Structure of Crystals, by the Abbé HAUR. From Vol. XVII. of the Annales de Chimie,*

[Concluded from p. 303.]

III. *Number of primitive Forms.*

IN the examples before mentioned I have chosen a parallelipipedon for nucleus, on account of the simplicity of its form. I have hitherto found that all the primitive forms may be reduced to six, viz. the parallelipipedon, in general, which comprehends the cube, the rhomboid, and all the solids

solids terminated by six faces parallel two and two; the regular tetraedron; the octaedron with triangular faces; the hexagonal prism; the dodecaedron with rhomboidal planes; and the dodecaedron with isosceles triangular planes.

Among these forms, there are some found as nucleus, which have the measure of their angles different in different kinds of minerals. This will appear less surprising when we consider that these nuclei are composed in the first instance of elementary molecularæ, and that it is possible the same form of nucleus may be produced in one kind by elements of a certain nature, and in another kind by different elements; as we see integral molecularæ, some cubic and others tetraedral, produce similar secondary forms, in consequence of different laws of decrement. But, it is worthy of remark, that all the forms, hitherto met with as nuclei, in the different species, are among the number of those which have a particular character of perfection and regularity, as the cube, the regular octaedron, the regular tetraedron, and the dodecaedron with equal and similar rhombuses for its planes. These forms are a sort of limits at which nature arrives by different routes, while each of the forms, placed between these limits, seems to be attached to one unique kind, at least as far as can be judged by the present state of our knowledge on this subject,

IV. *Forms of the integral Molecularæ.*

The primitive form is that obtained by sections made on all the similar parts of the secondary crystal; and these sections, continued parallel to themselves, conduct to a determination of the form of the integral molecularæ, of which the whole crystal is an assemblage. This requires certain considerations that relate to the most delicate point of the theory, which I shall now explain, with as much precision as the narrow limits to which I am obliged to confine myself will allow.

There

There is no crystal from which a nucleus in the form of a parallelopipedon may not be extracted, if we confine ourselves to six sections parallel two and two. In a multitude of substances this parallelopipedon is the last term of the mechanical division, and consequently the real nucleus. But there are certain minerals where this parallelopipedon is divisible, as well as the rest of the crystal, by farther sections made in the different directions of the faces; and there thence necessarily results a new solid, which will be the nucleus, if all the parts of the secondary crystal, super-added to this nucleus, are similarly situated. When the mechanical division conducts to a parallelopipedon, divisible only by sections parallel to its six faces, the moleculeæ are parallelopipedons similar to the nucleus; but, in all other cases, their form differs from that of the nucleus. This I shall illustrate by an example.

Let $acbsno$ (*fig. 60.*) be a cube, having two of its solid angles a, s , situated on the same vertical line. This line will be the axis of the cube; and the points a and s will be its summits. Suppose this cube to be divisible by sections, each of which, such as abn , passes through one of the summits a , and by two oblique diagonals ab, an , contiguous to this summit. This section will detach the solid angle i ; and as there are six solid angles, situated laterally, viz. i, b, c, r, o, n , the six sections will produce an acute rhomboid, the summits of which will be confounded with those of the cube. Figure 61 represents this rhomboid existing in the cube, in such a manner that its six lateral solid angles b, d, f, p, g, e , correspond to the middle of the faces $acbi, crsb, bins$, &c. of the cube. But geometry shews that each of the angles, at the summits bag, dsf, psg , &c. of the acute rhomboid, are equal to 60° , from which it follows that the lateral angles abf, agf , &c. are equal to 120° degrees.

Besides, it is proved by theory, that the cube results from a decrement which takes place by a single range of small rhomboids,

rhomboids, similar to the acute rhomboid, on the six oblique ridges ab, ag, ae, sd, sf, sp . This decrement produces two faces, one on each side of each of these ridges, which makes in all twelve faces. But as the two faces, which have the same ridge for their line of departure, are on the same plane by the nature of the decrement, the twelve faces will be reduced to six, which are squares; so that the secondary solid is a cube. This result is analogous to that of the very obtuse calcareous spar before mentioned.

Let us now suppose that the cube (*fig. 60.*) admits, in regard to its summits a, s , two new divisions similar to the preceding six, that is to say, one of which passes through the points c, i, o , and the other through the points b, n, r . The first will pass also through the points b, g, e , and the second through the points d, f, p , (*fig. 61 and 62.*) of the rhomboid; from which it follows, that these two divisions will detach each a regular tetraedron $bage$ or $dsfp$ (*fig. 62.*), so that the rhomboid will be found converted into a regular octaedron ef (*fig. 63.*), which will be the real nucleus of the cube; since it is produced by divisions similarly made, in regard to the eight solid angles of the cube.

If we suppose the same cube to be divisible, throughout its whole extent, by sections analogous to the preceding, it is clear that each of the small rhomboids of which it is the assemblage, will be found, in like manner, subdivided into an octaedron, with two regular tetraedra applied on the two opposite faces of the octaedron.

By taking the octaedron for nucleus, we may construct around this nucleus a cube by regular subtractions of small complete rhomboids. For example, if we suppose decrements by a single range of these rhomboids, having b for their point of departure, and made in a direction parallel to the inferior edges gf, eg, de, df , of the four triangles, which unite to form the solid angle b , there will result four faces, which will be found on a level, and, like the octaedron with six solid angles, similar decrements around the other

five angles will produce twenty faces, which, taken four and four, will be equally on a level, which will make, in the whole, six distinct faces; situated as those of the cube (*fig. 60.*); so that the result will be precisely the same as in the case of the rhomboid considered as nucleus.

In whatever manner we proceed to subdivide either the cube, the rhombus, or the octaedron, we shall always have solids of two forms, that is to say, octaedra and tetraedra, without ever being able to reduce the result of the division to unity. But the molculæ of a crystal being necessarily similar, it appeared to me probable that the structure was as it were interspersed with a multitude of small vacuities, occupied either by the water of crystallisation or by some other substance; so that, if it were possible to carry the division to its limits, one of the two kinds of solids in question would disappear, and the whole crystal would be found composed only of molculæ of the other form.

This idea is the more admissible, as each octaedron being enveloped by eight tetraedra, and each tetraedron being equally enveloped by four octaedra, whichever of the forms we imagine to be suppressed, the solids that remain will join exactly by their edges; so that, in this respect, there will be continuity and uniformity throughout the whole extent of the mass. The manner in which each octaedron is enveloped by eight tetraedra may be readily conceived, if we take care that in dividing the cube (*fig. 60.*) only by the six sections given by the rhombus, we may depart at pleasure from any two, a, s ; o, b ; c, n ; i, r , of the eight solid angles, provided that these two angles be opposite to each other. But if we depart from the angles a, s , the rhomboid will have the position shewn *fig. 62.* On the other hand, if we depart from the solid angles o, b , these angles will become the summits of a new rhomboid (*fig. 64.*) composed of the same octaedron as that of *fig. 63*, with two new tetraedra applied on the faces bdf, egp (*fig. 64.*), which were unoccupied on the rhomboid of *fig. 62.* Figures 65 and 66 represent,

one, the case in which the two tetraedra repose on the faces dbe , fgp , of the octaedron; the other, that in which they would rest on the faces bfg , dep . It is thence seen, that whatever may be the two solid angles of the cube assumed for the points of departure, we shall always have the same octaedron, with two tetraedra contiguous by their summits to the two solid angles in question; and as there are eight of these solid angles, the central octaedron will be circumscribed by eight tetraedra, which will rest on its faces. The same effect will take place if we continue the division always parallel to the first sections. Each face of the octaedron, then, however small we may suppose that octaedron to be, adheres to a face of the tetraedron, and reciprocally. Each tetraedron then is enveloped by four octaedra.

The structure I have here explained is that of sparry fluor. By dividing a cube of this substance we may, at pleasure, extract rhomboids, having the angles formed by their planes equal to 120° or regular octaedra, or tetraedra, equally regular. There are a small number of other substances, such as rock crystal*, carbonate of lead (sparry lead), &c. which being mechanically divided beyond the term at which we should have a rhomboid or parallelopipedon, give also parts of various different forms assorted together in a manner even more complex than in sparry fluor. These mixt structures necessarily occasion uncertainty respecting the real figure of the integral molecule which belong to the substances in question. I have, however, observed that the tetraedron is always one of those solids which concur to the formation of small rhomboids or parallelopipedons that would be drawn from the crystal by a first division. On the other hand, there are substances, which, being divided in all possible directions, resolve themselves only into tetraedra. Of this number are garnet, blend, and tourmaline. I shall soon give examples of this result of the mechanical division.

* Mémoires de l'Acad. des Sciences, An 1786, p. 78.

In short, several minerals are divisible into right triangular prisms. Such as the apatite, the primitive form of which is a regular right hexaedral prism, divisible parallel to its bases and its planes, from which necessarily result right prisms with three planes, as may be seen by inspecting *fig. 68*, which represents one of the bases of the hexaedral prism divided into small equilateral triangles, which are the bases of so many *moleculæ*, and which, being taken two and two, form quadrilateral prisms with rhombuses for their bases.

By adopting then the tetraedron in the doubtful case of which I have spoken, we should reduce, in general, all the forms of integral *moleculæ* to three, remarkable by their simplicity; viz. the parallelopipedon, the simplest of all the solids which have faces parallel two and two; the triangular prism, the simplest of all prisms, and the tetraedron, which is the simplest of pyramids. This simplicity may furnish a reason for the preference given to the tetraedron in sparry fluor, and the other substances of which I have spoken. I shall, however, forbear deciding on this subject, as the want of accurate and precise observations leaves to theory nothing but conjectures and probabilities.

But the essential object is, that the different forms to which the mixt structures in question conduct, are assorted in such a manner, that their assemblage is equivalent to a sum of small parallelopipedons, as we have seen to be the case in regard to sparry fluor; and that the laminæ of superposition, applied on the nucleus, decrease by subtractions of one or more ranges of these parallelopipedons; so that the basis of the theory exists independently of the choice which might be made of any of the forms obtained by the mechanical division.

By the help of this result, the decrements to which crystals are subject, whatever be their primitive forms, are found brought back to those which take place in substances where this form, as well as that of the *moleculæ*, are indivisible
 paral-

parallelipèdons; and theory has the advantage of being able to generalise its object, by connecting with one fact that multitude of facts which by their diversity seem to be little susceptible of concurring in a common point.

What has been here said will be better illustrated by a few examples of the manner in which we may reduce to the theory of the parallelipèdon that of the forms different from that solid.

Crystals, the moleculess of which are tetraedra with isosceles triangular faces.

Garnet.

1. Primitive garnet (*fig. 68.*) *Grenat à douze faces.* Daubenton *Tab. Miner.* edit. 1792, p. 5. *Grenat dodécaèdre à plans rhombes.* De l'Isle *Crysallographie*, tom. ii. p. 322. var. 1.

Geomet. charact. Respective inclination of any two of the faces of the dodécaèdron 120° . Angles of the rhombus CLGH, C or G = $109^\circ 28' 16''$; L or H = $78^\circ 31' 44''$.

Though garnets of the primitive form be in general vitreous on the fractures, there are perceived on them, however, laminæ situated parallel to the rhombuses which compose their surface. Let us suppose the dodécaèdron divided in the direction of its laminæ, and, for the greater simplicity, let us make the sections pass through the centre. One of these sections, viz. that which will be parallel to the two rhombuses DLFN, BIOR, will concur with a hexagon which would pass through the points E, C, G, P, F, A, by making the tour of the crystal. A second section parallel to the two rhombuses GLFP, BEAR, will coincide with another hexagon shewn by the points D, C, H, O, I, N. If the division be continued parallel to the other eight rhombuses, taken two and two, we shall find that the planes of the sections will be confounded with four new hexagons analogous to the preceding. But by resuming all these hexagons it is seen that their sides correspond, some of them with

the

the small diagonals of the rhombuses of the dodecaedron, viz. those which would be drawn from C to G, from A to I, from C to B, &c. and others would correspond with the different ridges EC, GP, PI, EA, &c.

1. The planes then of the sections passing through the sides and through the small diagonals of the twelve rhombuses will subdivide the whole surface into 24 isosceles triangles, which will be the halves of these rhombuses. 2. Since the planes of the sections pass also through the centre of the crystal, they will detach 24 pyramids with three faces, the bases of which, if we choose, will be the external triangles that make a part of the surface of the dodecaedron, and of which the summits will be united in the centre.

Moreover, if we take, for example, the six tetraedra which have for external faces the halves of the three rhombuses CEDL, CLGH, CEBH, these six tetraedra will form a rhomboid represented by *fig. 69*, and in which the three inferior rhombuses DLGS, GHBS, DEBS, result from three divisions which pass, one through the hexagon DLGORA (*fig. 68.*); the second through the hexagon GHBANF, and the third through the hexagon BEDFPO. *Fig. 69* represents also the two tetraedra, the bases of which make part of the rhombus CLGH. One of these is marked by the letters L, C, G, S, and the other by the letters H, C, G, S. By applying what has been said to the other nine rhombuses, which are united three and three around the points F, A, H (*fig. 69.*), we shall have three new rhomboids; from which it follows, that the 24 tetraedra, considered six and six, form four rhomboids; so that the dodecaedron may be conceived as being itself immediately composed of these four rhomboids, and in the last analysis of 24 tetraedra.

I shall here observe, that the dodecaedron having eight solid angles, each formed by three planes, we might have considered them as being the assemblage of the four rhomboids, which would have for exterior summits the four angles

G,

G, B, D, A; from which it results that any one of the faces, such as CLGO, is common to two rhomboids, one of which would have its summit in C, and the other in G, and which would themselves have a common part in the interior of the crystal.

It may be farther remarked, that a line GS (*fig. 69.*), drawn from any one G (*fig. 68.*) of the solid angles composed of three planes, as far as the centre of the dodecaedron, is, at the same time, the axis of the rhomboid, which would have its summit in G, and one of the edges of that which would have its summit in C (*fig. 68 and 69.*). The composing rhomboids then have this property, that their axis is equal to the side of the rhombus. With a little attention it will be easily seen, that in each tetraedron, such as CLGS (*fig. 69.*), all the faces are equal and similar isosceles triangles.

If we should continue the division of the dodecaedron by sections passing between those which we have supposed to be directed towards the centre, and which should be parallel to them, we should obtain tetraedra always smaller, and arranged in such a manner, that, taking them in groupes of six, they would form rhomboids of a bulk proportioned to their own.

The tetraedra, which would be the term of the division, were it possible for us to reach it, ought to be considered as the real molecule of the garnet. But we shall see, that, in the passage to the secondary forms, the laminæ of superposition, which envelop the nucleus, really decrease by ranges of small rhomboids, each of which is the assemblage of six of these tetraedra.

The sulphure of zinc or blend has the same structure as the garnet. I have divided by very clean sections fragments of this substance, in such a manner as to obtain successively the dodecaedron, the rhomboid, and the tetraedron.

2. Trapezoidal Garnet (Fig. 70.).

Grenat à 24 faces. Daubenton *Tab. Miner.* edit. 1792, p. 5. *Grenat à 24 facettes trapezoidales.* De l'Isle *Crytallographie*, tom. ii. p. 327.

Geomet. charact. Respective inclination of the trapezoids united three and three around the same solid angle D, C, G, &c. $146^{\circ} 26' 33''$; of the trapezoids united four and four around the same solid angle u, x, r , &c. $131^{\circ} 48' 36''$. Angles of any one of the trapezoids m D u L, $L = 78^{\circ} 27' 46''$; $D = 117^{\circ} 2' 8''$; m or $u = 82^{\circ} 15' 3''$. The value of the angle L is the same as that of the acute angle of the nucleus of calcareous spar.

This variety results from a series of laminae decreasing at the four edges, on all the faces of the primitive dodecaedron. For the more simplicity, let us first consider the effect of this decrement in regard to the rhombus CLGH (*fig.* 68.). We have just seen that this rhombus was supposed to belong in common to two rhomboids, which should have for summits, one, the point C, and the other, the point G. Let us suppose that the laminae applied on this rhombus decrease towards their four edges by subtractions of a single range of small rhomboids, in such a manner that, in regard to the two edges CL, CH, circumstances are the same as if the rhombus belonged to the rhomboid which has its summit in C; and that, in regard to the other two edges GL, GH, the effect is the same as if the rhombus belonged to the rhomboid having its summit in G. This disposition is admissible here, in consequence of the particular structure of the dodecaedron, which permits us to obtain small rhomboids, some of which have their faces parallel to the faces of that with its summit in C, and the rest to that having its summit in G*.

The

* Theory has conducted me to another result, which is, that the sum of the nucleus and laminae of superposition, taken together in proportion

The results of the four decrements being thus perfectly similar to each other, the laminæ of superposition, applied on the rhombus $CLGH$, and on each of the other rhombuses of the dodecaedron, will form as many right quadrangular pyramids, which will have for bases these same rhombuses. In *fig. 71* may be seen the pyramids which rest on the three rhombuses $CLDE$, $CEBH$, $CGHB$ (*fig. 68.*), and which have for summits the points m , e , s (*fig. 71.*); but on account of the decrement by a simple range, the adjacent triangular faces, such as EmC , EsC of the two pyramids that belong to the rhombuses $CLDE$, $CEBH$, are on a level, and form a quadrilateral $EmCs$. But we had twelve pyramids, and consequently forty-eight triangles. Dividing by two, we shall then have twenty-four quadrilaterals, which will compose the surface of the secondary crystal. But because the rhomboidal bases of the two pyramids extend more, in proceeding from L to E or from H to E , than in proceeding from D to C or from B to C , the sides mE , Es of the quadrilateral will be longer than the sides Cm , Cs . Moreover, we shall evidently have mE equal to Es , and Cm equal to Cs . The quadrilaterals will then be trapezoids, which will have their sides equal two and two.

I am acquainted with no crystalline form where the striæ, when they exist, point out, in a more sensible manner than in this, the mechanism of the structure. We may here see the series of decreasing rhombuses which form each of the pyramids $CLDEm$, $CEBHs$, &c. (*fig. 71.*), and sometimes the furrows are so deep that they produce a kind of stair, the steps of which have a more particular polish and brilliancy than those of their facets, which are parallel to the faces $CEDL$, $CHBE$, &c. of the nucleus.

as the latter are applied one upon the other, is always equal to a sum of rhomboids, though at first view it does not appear that this should be the case, according to the figure of these laminæ, which represent rising pyramids. See *Mémoires de l'Acad.* 1789, p. 325.

If the decrements stop abruptly at a certain term, so that the pyramids are not terminated, the twenty-four trapezoids will be reduced to elongated hexagons, which will intercept twelve rhombuses parallel to the faces of the nucleus. This is the variety to which I have given the name of *intermediary garnet*..

In the sulphure of zinc the regular octaedron results from a decrement by a range around the eight solid angles, composed of three planes, viz. C, B, O, G, F, D, A, I (*fig. 68.*). The same substance assumes also the figure of a regular tetraedron, by the help of a decrement by one range on four only of the eight solid angles before mentioned, such as C, O, F, A. This tetraedron is remarkable by its structure, which presents an assemblage of other tetraedra with isosceles faces.

Crystals the Molecule of which are triangular Prisms.

Oriental.

I give this appellation to a kind of gem known under the names of the *ruby*, *sapphire*, *oriental topaz*, according as it is red, blue or yellow. It is so rare to find crystals of this gem which do not exhibit marks of a precipitate formation, or which have not been rolled, that hitherto we have had no accurate description of its different varieties, nor any precise indication of the nature of the particular angles of each variety. The crystals which enabled me to establish the following results were of a form sufficiently well characterised.

1. Primitive Oriental.

It crystallises in the form of a regular hexaedral prism divisible parallel to its bases. Theory points out other joinings, parallel to the planes, from which it follows, that the molecule is an equilateral triangular prism. The height of this prism, such as given by theoretic calculation, is a little less than three times the height of the triangle of the base.

2. Elong-

2. *Elongated Oriental* (fig. 72.).

De l'Isle *Crystallographie*, tom. ii. p. 215. A.

Geomet. charact. Respective inclinations of the triangles I A S, I B S, $139^{\circ} 54'$. Angles of the triangle I A S, $A = 22^{\circ} 54'$, I or S $= 78^{\circ} 48'$.

This form is the effect of a decrement by a simple range of small quadrangular prisms on all the edges of the bases of the nucleus. Let $q d$ (fig. 67.) be the superior base, subdivided into small triangles, which represent the analogous bases of so many molecu \ddot{a} e. The edges of the lamin \ddot{a} e of superposition will correspond successively to the hexagons $hilmnr$, $ekuxyv$, &c.; from which it evidently follows, that the subtractions take place, as I have said, by ranges of small parallelipedons or quadrangular prisms, composed each of two triangular prisms.

3. *Minor Oriental*.

Geomet. charact. Dodecaedron formed of two right pyramids less elongated than those of the preceding variety. The triangles which correspond to I A S, I B S, are inclined to each other $122^{\circ} 36'$. In each of these triangles the angle of the summit is 31° , and each of the angles at the base is $74^{\circ} 30'$.

The law from which this variety results differs from that which produces the preceding, as it determines a mixed decrement by three ranges in breadth and two ranges in height.

4. *Enneagonal Oriental* (fig. 73.).

Geomet. charact. Inclination of each small triangle, such as cqi to the adjacent base $aciplbged$, $122^{\circ} 18'$.

It is the elongated oriental the summits of which are replaced by two faces, parallel to the bases of the nucleus, with the addition of six small isosceles triangles cqi , lbf , vzm , &c. the three superior of which are alternate in position with the three inferior. These triangles result from a decrement by three ranges of small quadrangular prisms on

the three angles of the superior base of the nucleus, such as b , d , g , (*fig. 67.*), and on the intermediate angles of the inferior base. It may be readily conceived, that in the decrement which takes place, for example, on the angle g , the three ranges, which remain unoccupied between that angle and the corresponding edge of the first lamina of superposition, are, 1st, the small rhombus $goip$, which alone forms the first range; 2d, the two rhombuses $osti$, $pædi$; 3d, the three rhombuses situated on the same line behind the two preceding.

Crystals of the oriental are found particularly in the kingdom of Pegu. There are also in France sapphires called the sapphires of Puy. They are found at the distance of a league from Velai, on the banks of a rivulet near the village of Expailly, where they are mixed with garnets and hyacinths. These sapphires have all the characters of the stone called *oriental sapphire*.

V. *Difference between Structure and Increment.*

In what I have hitherto said respecting the decrements to which the laminæ of superposition are subjected, my only view was to unfold the laws of structure; and I am far from believing that, in the formation of a dodecaedral crystal, or one of any other form having a cube for nucleus, the crystallisation has originally produced that nucleus such as it is extracted from the dodecaedron, and made it afterwards pass to the figure of that dodecaedron, by the successive application of all the laminæ of superposition by which it is covered. On the contrary, it seems proved, that from the first moment the crystal is already a very small dodecaedron, containing a cubical nucleus proportioned to its small size, and that the crystal afterwards increases by degrees without changing its form, by new layers which envelop it on all sides, so that the nucleus increases also, always preserving the same relation with the whole dodecaedron.

Let us make this more striking by an example taken from a plane figure. What I am going to observe respecting this figure may be easily applied to a solid, since we may always conceive a plane figure as a section of a solid. Let $ERFN$ then (*fig. 74.*) be an assortment of small squares, in which the square $ABCD$, composed of forty-nine partial squares, represents a section of the nucleus, and the extreme squares R, S, G, A, I, L , &c. that of the kind of stair formed by the laminæ of superposition. It may be readily conceived that the assortment began by the square $ABCD$; and that different files of small squares were afterwards applied on each of the sides of the central square, for example, on the side AB , first the five squares comprehended between I and M , next the three squares comprehended between L and O , and then the square E . This increment corresponds with that which would take place if the dodecaedron began by being a cube, proportioned to its bulk, and which increased afterwards by the addition of continually decreasing laminæ.

But, on the other hand, we may conceive that the assortment was at first like that represented by *fig. 76*, in which the square $abcd$ is composed of only nine molecule, and bears upon each of its sides only one square e, n, f , or r ; and that afterwards, by means of the application of new squares, arranged around the former, the assortment has become that of *figure 75*, where the central square $a'b'c'd'$ is formed of twenty-five small squares, and bears on each of its sides a file of three squares, plus a terminating square e', n', f' or r' , and that, in short, by a farther application the assortment of *fig. 75* is converted into that of *fig. 74*. These different transitions will give an idea of the manner in which secondary crystals may augment in bulk, yet retain their form; from which it is seen that the structure is combined with that augmentation of bulk, so that the law, according to which all the laminæ applied in the nucleus of the crystal, when arrived at its greatest dimensions, successively

decrease, in departing from this nucleus, existed already in the rising crystal.

The theory I have explained, similar in this to other theories, sets out from a principal fact, on which it makes all facts of the same kind to depend, and which are only as it were corollaries. This fact is the decrement of the laminae superadded to the primitive form; and it is by bringing back this decrement to simple and regular laws, susceptible of accurate calculation, that theory arrives at results the truth of which is proved by the mechanical division of crystals, and by observation of their angles. But there still remain new researches to be made, in order to ascend a few steps farther towards the primitive laws to which the Creator has subjected crystallisation; and which are nothing else themselves than the immediate effects of his supreme will. The object of one of these researches would be to explain how these small polyedra, which are, as it were, the rudiments of crystals of a sensible bulk, represent sometimes the primitive form, without any modification; sometimes a secondary form produced in virtue of a law of decrement; and to determine the circumstances which produce decrements on the edges, and those which give rise to decrements on the angles. I have already paid attention to the solution of this problem, as delicate as it is interesting; but hitherto I have only had conjectures, which, before they deserve to be published, require to be verified by more attentive labour and more profound meditation.

IX. *On the Principles of Equilibrium, and the Stability of floating Bodies applied to River and Canal Boats of different Forms.* By Mr. JOHN GEORGE ENGLISH, Teacher of Mathematics and Mechanical Philosophy. Communicated by the Author.

THE principles of dynamics in general, and of statics in particular, have already been so fully explained by some of the ablest mathematicians in Europe, that little or nothing of consequence is farther to be expected on those subjects, unless our mode of calculus be either greatly improved or totally changed. And as neither of these events is likely soon to take place, we ought certainly, in the mean time, to apply to the common concerns of life the principles of which we are already in possession. But since war and merchandisè seem at present to be the chief business of all European nations, and since neither the one nor the other can be carried on to any great extent without navigation, nor can any vessel with safety be navigated without a proper degree of stability; it is therefore a matter of the greatest importance to determine with accuracy the stability of nautical vessels of all kinds.

However operose and difficult the necessary calculations, may in some cases become before the degree of this essential quality can be obtained, yet they all depend upon the four following simple and obvious theorems, accompanied with other well known stereometrical and statical principles.

THEOREM I. Every floating body displaces a quantity of the fluid in which it floats, equal to its own weight: and consequently, the specific gravity of the fluid will be to that of the floating body, as the magnitude of the whole is to that of the part immersed.

THEOREM II. Every floating body is impelled downward by its own essential power, acting in the direction of a vertical line passing through the centre of gravity of the whole;

whole; and is impelled upward by the re-action of the fluid which supports it, acting in the direction of a vertical line passing through the centre of gravity of the part immersed: therefore, unless these two lines are coincident, the floating body thus impelled must revolve round an axis, either in motion or at rest, until the equilibrium is restored.

THEOREM III. If by any power whatever a vessel be deflected from an upright position, the perpendicular distance between two vertical lines passing through the centres of gravity of the whole, and of the part immersed respectively, will be as the stability of the vessel, and which will be positive, nothing, or negative, according as the metacentre is above, coincident with, or below, the centre of gravity of the vessel.

THEOREM IV. The common centre of gravity of any system of bodies being given in position, if any one of these bodies be moved from one part of the system to another, the corresponding motion of the common centre of gravity, estimated in any given direction, will be to that of the aforesaid body, estimated in the same direction, as the weight of the body moved is to that of the whole system.

From whence it is evident, that in order to ascertain the stability of any vessel, the position of the centres of gravity of the whole, and of the part immersed must be determined; with which, and the dimensions of the vessel, the line of floatation, and angle of deflection, the stability or power either to right itself or overturn may be found.

In ships of war and merchandize, the calculations necessary for this purpose become unavoidably very operose and troublesome; but they may be much facilitated by the experimental method pointed out in the *New Transactions of the Swedish Academy of Sciences*, first quarter of the year 1787; page 48.

In river and canal boats, the regularity and simplicity of the form of the vessel itself, together with the compact disposition and homogeneous quality of the burden, render that method for them unnecessary, and make the requisite calculations

lations become very easy. Vessels of this kind are generally of the same transverse section throughout their whole length, except a small part in prow and stern, formed by segments of circles or other simple curves; therefore a length may easily be assigned such, that any of the transverse sections being multiplied thereby, the product will be equal to the whole solidity of the vessel. The form of the section ABCD is for the most part either rectangular as in *fig. 1.* (*Plate XIII.*), trapezoidal as in *fig. 2.* or mixtilineal as in *fig. 3.* in all which MM represents the line of floatation when upright, and EF that when inclined at any angle M X E; also G represents the centre of gravity of the whole vessel, and R that of the part immersed.

If the vessel be loaded quite up to the line AB, and the specific gravity of the boat and burden be the same, then the point G is simply the centre of gravity of the section ABCD; but if not, the centres of gravity of the boat and burden must be found separately, and reduced to one by the common method, namely, by dividing the sum of the momenta by the sum of weights, or areas, which in this case are as the weights. The point R is always the centre of gravity of the section MMCD, which, if consisting of different figures, must also be found by dividing the sum of the momenta by the sum of the weights as common. These two points being found, the next thing necessary is to determine the area of the two equal triangles M X E, M X F, their centres of gravity *o, o*, and the perpendicular projected distance *nn* of these points on the water line EF. This being done, through R and parallel to EF draw RT = *a* fourth proportional to the whole area MMCD, either triangle M X E or M X F, and the distance *nn*; through T, and at right angles to RT or EF, draw TS meeting the vertical axis of the vessel in S the metacentre; also through the points G, B, and parallel to ST, draw NGW and BV; moreover through S, and parallel to EF, draw WSV meeting the two former in V and W; then SW is

as the stability of the vessel, which will be positive, nothing, or negative, according as the point S is above, coincident with, or below, the point G. If now we suppose W to represent the weight of the whole vessel and burden (which will be equal to the section MMCD multiplied by the length of the vessel), and P to represent the required weight applied at the gunwale B to sustain the vessel at the given angle of inclination; we shall always have this proportion: as VS : SW :: W : P; which proportion is general, whether SW be positive or negative; it must only in the latter case be supposed to act upward to prevent an overturn.

In the rectangular vessel, of given weight and dimensions, the whole process is so evident, that any farther explanation would be unnecessary. In the trapezoidal vessel, after having found the points G and R, let AD, BC be produced until they meet in K. Then since the two sections MMCD, EFDC are equal, the two triangles MMK, EFK are also equal; and therefore the rectangle $EK \times KF = KM \times KM = \overline{KM}^2$; and since the angle of inclination is supposed to be known, the angles at E and F are given. Consequently, if a mean proportional be found between the sines of the angles at E and F, we shall have the following proportions:

As the mean proportional thus found: sine $\angle E :: KM : KF$,
And as the said mean proportional: sine $\angle F :: KM : KE$;
therefore ME, MF become known; from whence the area of either triangle MXE or MXF, the distance nn , and all the other requisites may be found.

In the mixtilineal section, let AB = 9 feet = 108 inches, the whole depth = 6 feet = 72 inches, and the altitude of MM the line of floatation 4 feet or 48 inches; also let the two curvilinear parts be circular quadrants of 2 feet, or 24 inches radius each. Then the area of the two quadrants = 904.7808 square inches, and the distance of their centres of gravity from the bottom = 13.8177 inches very nearly; also the

the area of the included rectangle $abie = 1440$ square inches, and the altitude of its centre of gravity 12 inches; in like manner the area of the rectangle $ABcd$ will be found $= 5184$ square inches, and the altitude of its centre of gravity 48 inches; therefore we shall have

Momentum of the 2 quadrants $= 904.7808 \times 13.8177 = 12501.98966016$	
Momentum of the rectan. $abie = 1440 \times 12 = 17280$	
Momentum of the rectan. $ABcd = 5184 \times 48 = 248832$	
7528.7808	278613.98966016

Now the sum of the momenta divided by the sum of the areas will give $\frac{278613.98966016}{7528.7808} = 37.006$ inches, the altitude of G the centre of gravity of the section $ABCD$ above the bottom. In like manner the altitude of R the centre of gravity of the section $MMCD$ will be found to be equal $\frac{123093.98966016}{4936.7808} = 24.934$ inches; and consequently their difference, or the value of $GR = 12.072$ inches, will be found.

Suppose the vessel to heel 15° , and we shall have the following proportion, namely, As radius : tangent of $15^\circ :: MX = 54$ inches : 14.469 inches $= ME$ or MF ; and consequently the area of either triangle MXE or $MXF = 390.663$ square inches. Therefore, by theorem 4th, As $4936.7808 : 390.663 :: 72 = mn = \frac{2}{3}AB : 5.6975$ inches $= RT$; and again, As radius : sine of $15^\circ :: 12.072 = GR : 3.1245$ inches $= RN$; consequently $RT - RN = 5.6975 - 3.1245 = 2.573$ inches $= SW$ the stability required.

Moreover, As the sine of 15° : radius $:: 5.6975 = RT : 22.013 = RS$, to which if we add 24.934 , the altitude of the point R , we shall have 46.947 for the height of the metacentre, which taken from 72 , the whole altitude, there remains 25.053 ; from which and the half width $= 54$ inches, the distance BS is found $= 59.529$ inches very nearly,

nearly, and the angle $SBV = 80^{\circ} - 06' - 42''$; from whence $SV = 58.645$ inches.

Again: Let us suppose the mean length of the vessel to be 40 feet, or 480 inches, and we shall have the weight of the whole vessel equal to the area of the section $MMCD = 4936.7808$ multiplied by 480 = 2369654.784 cubic inches of water, which weighs exactly 85708 pounds avoirdupoise, allowing the cubic foot to weigh 62.5 pounds.

And, finally, as $SV : SW$ (*i. e.*) as $58.645 : 2.573 :: 85708 : 3760 +$, the weight on the gunwale which will sustain the vessel at the given inclination. Therefore a vessel of the above dimensions, and weighing 38 tons, 5 cwt. 28 lbs. will require a weight of 1 ton, 13 cwt. 64 lbs. to make her incline 15° .

In this example the deflecting power has been supposed to act perpendicularly on the gunwale at B; but if the vessel is navigated by sails, the centre velique must be found; with which, and the angle of deflection, the projected distance thereof on the line SV may be obtained; and then the power, calculated as above, necessary to be applied at the projected point, will be that part of the wind's force which causes the vessel to heel. And conversely, if the weight and dimensions of the vessel, the area and altitude of the sails, the direction and velocity of the wind be given, the angle of deflection may be found.

X. *New Method of freeing Molasses from their sharp Taste, and rendering them fit to be used instead of Sugar.*
From Crell's Chemical Annals, 1798, Vol. I. Part 2.

CADET DEVAUX, according to the experiments made by Lowitz, gives the following method: Take twenty-four pounds of molasses, twenty-four pounds of water, and six pounds of charcoal coarsely pulverised; and having mixed them in a kettle, boil the whole over a slow wood fire.

When the mixture has boiled half an hour, pour it into a flat vessel, in order that the charcoal may subside to the bottom; then pour off the liquid, and place it over the fire once more, that the superfluous water may evaporate, and to give to the molasses their former consistence. Twenty-four pounds of molasses will produce twenty-four pounds of syrup.

This method has been employed on a large scale with the happiest effects; the molasses become sensibly milder, and can be employed in many articles of food; though in dishes where milk is used, or for cordials mixed with spices, sugar is to be preferred.

XI. Description and Use of the Dynamometer, or Instrument for ascertaining the relative Strength of Men and Animals. Invented by Cit. REGNIER. From Journal de l'Ecole Polytechnique, Vol. II. 6th Year.

WHEN Sanctorius invented his balance, he taught us what we lose by insensible perspiration; and no one, without this discovery, would perhaps ever have imagined that the matter thrown out from the body is more than half what we receive as nourishment. Knowledge no less important might be acquired, had we the easy means of ascertaining, in a comparative manner, our relative strengths at the different periods of life, and in different states of health. Buffon and Gueneau, who had some excellent ideas on this subject, requested me to endeavour to invent a portable machine, which, by an easy and simple mechanism, might conduct to a solution of this question, on which they were then engaged. These philosophers were acquainted with that invented by Graham, and improved by Dr. Desaguliers, at London; but this machine, constructed of wooden-work, was too bulky and heavy to be portable; and, besides, to make experiments on the different parts of the body, several machines

machines were necessary, each suited to the part required to be tried. They were acquainted also with the dynamometer of Cit. Leroy of the Academy of Sciences at Paris. It consisted of a metal tube ten or twelve inches in length, placed vertically on a foot like that of a candlestick, and containing in the inside a spiral spring, having above it a graduated shank terminating in a globe. This shank, together with the spring, sunk into the tube in proportion to the weight acting upon it, and thus pointed out, in degrees, the strength of the person who pressed on the ball with his hand.

This instrument, though ingenious, did not appear sufficient however to Buffon and Gueneau; for they wished not merely to ascertain the muscular force of a finger or hand, but to estimate that of each limb separately, and of all the parts of the body. I shall not here give an account of the attempts I made to fulfil the wishes of these two philosophers, but only observe, that in the course of my experiments I had reason to be convinced that the construction of the instrument was not so easy as might have been expected. Besides the use which an enlightened naturalist may make of this machine, it may be possible to apply it to many other important purposes. For example, it may be employed with advantage to determine the strength of draught cattle; and, above all, to try that of horses, and compare it with the strength of other animals. It may serve to make known how far the assistance of well-constructed wheels may favour the movement of a carriage, and what is its *vis inertiae* in proportion to the load. We might appreciate by it, also, what resistance the slope of a mountain opposes to a carriage, and be able to judge whether a carriage is sufficiently loaded in proportion to the number of horses that are to be yoked to it. In the arts, it may be applied to machines of which we wish to ascertain the resistance, and when we are desirous to calculate the moving force that ought to be adapted to them. It may serve, also,

as a Roman balance to weigh burdens. In short, nothing would be more easy than to convert it into an anemometer, to discover the absolute force of the wind, by fitting to it a frame of a determined size filled up with wax-cloth; and it would not be impossible to ascertain by this machine the recoil of fire-arms, and consequently the strength of gun-powder.

This dynamometer, in its form and size, has a near resemblance to a common graphometer. It consists of a spring twelve inches in length, bent into the form of an ellipsis; from the middle of which arises a semicircular piece of brass, having engraved upon it the different degrees that express the force of the power acting on the spring. The whole of this machine, which weighs only two pounds and a half, opposes, however, more resistance than may be necessary to determine the action of the strongest and most robust horse. The simplicity of its mechanism will be better illustrated by the following description:

A, an elliptical spring, seen in perspective, covered with leather, that it may not hurt the fingers when strongly pressed on with the hands, (*see Plate XIII.*) This spring is composed of the best steel well welded and tempered, and afterwards subjected to a stronger proof than is indicated by its graduation, in order that it may not lose any of its elasticity by use.

B, a piece of steel strongly fastened to the spring by means of a claw and screws, in order to support a semicircular plate of brass C, mounted on the spring, seen geometrically. On this plate are engraved two arcs, one divided into myriagrammes, and the other into kylogrammes. Each of these arcs is still farther divided by points, which express the weight in pounds *de marc*; and all these degrees having been exactly valued by accurate weights, it thence results that all dynamometers of this kind may be compared with each other.

D, a small steel support, adjusted like the former to the other branch of the spring, and having a cleft towards its upper extremity to receive freely a small copper lever E, which is kept in its place by a small steel pin *a*. The whole of this mechanism is seen of its full size at H.

F, a steel index, very light and elastic, fixed upon its axis by a screw in the centre of the brass semicircle. This index has a small bit of leather or cloth glued upon the small circular part G, in order to render the friction on the plate easy, uniform, and almost insensible. It is to be observed, that this index is terminated by a double point, adapted to the divisions on both the semicircular arcs. The first, divided into myriogrammes and points, expressing ten pounds *de marc*, serves for all experiments which oblige the spring to be elongated in the direction of its greater axis, as is the case in trying the strength of the reins; in a word, for all trials where it is necessary to draw the spring by the two ends. The second, divided into kylogrammes and points, expressing pounds *de marc*, is destined for experiments which compress the two sides of the spring, as in trying the force of the hands.

J, a small plate of brass which covers the mechanism, to prevent it from being injured. This small plate has on it also a divided arc, the degrees of which correspond with those of the first arc of the machine; and by the play of a small index *b*, which is under the plate, the movements of the spring may be ascertained.

K, an aperture in the covering plate, through which may be introduced a small turn-screw, for the purpose of tightening or easing the index as may be necessary.

L, a pallet of brass, with a screw, having a cap like that on the needle of the mariner's compass, in which the lower pivot of the lever, that pushes round the index or handle, is made to play. This pallet, acting as a spring, yields to any sudden shock, and prevents the derangement of the mechanism.

M, a

M, a socket riveted on the plate J, in which the upper pivot of the lever turns.

N, N, N, small cylindric pillars that support the covering plate, which is fixed to them by three screws.

O, an iron rack, on the lower part of which the feet must be placed when it is intended to try the strength of a person's body.

P, a double handle of wood, with an iron hook, to be held at the same time in the two hands.

Q, a double hook made of iron, one end of which is to be hooked to the end of the spring, and the other to a rope fastened to a stake, as at *c*, when experiments are to be made on the strength of horses, or others, that require the dynamometer to be supported by hooks.

R, the manner of holding the dynamometer to ascertain the strength of the hands.

S, position of a man when trying the strength of his reins.

T, disposition of the dynamometer to try the strength of a horse or any other draught animal.

The effects of this machine may be thus explained: If a person presses on the spring with the hands, or draws it out lengthwise, by pulling the two extremities in a contrary direction, the two sides of the spring approach each other; and in proportion as they are brought nearer, the small lever of the mechanism pushes before it the index, which, by the tightness with which it is screwed in its place, will remain at the point to which it has been brought by the pin *d*, in consequence of the force acting on the spring.

The muscular force of the arms, or rather the strength of the hands, may be tried by laying hold of the two sides of the spring nearest to the centre, as may be seen figure R; so that the arms may be a little stretched, and inclined downwards, almost at an angle of 45 degrees. This position, which appears the most natural, is also the most convenient for a man to act with his full force. It is to be

D d 2

recollected,

recollected, that the lower arc of division, divided into kylogrammes, is that which serves to express the force of hands, and of all the actions which press the two sides of the spring. The strength of the hands may also be tried one after the other; and if an account be kept of the degree of pressure of the right hand, and then of the left, and these two sums be added together, it will be found that the sum-total is, in general, equal to the strength of both the hands when acting together.

To try the strength of the body, or rather the reins, the person must place his feet on the bottom part of the rack O; one of the ends of the spring is then to be placed in one of the hooks of the rack; and the hook P is to be put into the other end. In this position the body is perpendicular; the shoulders only being inclined a little forwards, to be able, in throwing back the body, to pull the spring with all the force which a person is capable of exerting. In this situation, represented by S, a man may raise a great weight without being exposed to those accidents which might be occasioned by an effort made in a more constrained position.

Nothing can be more convenient than this dynamometer to ascertain and compare the strength of horses and that of all draught animals. Figure T shews, in a sufficient manner, the dispositions necessary for experiments of that kind. The trials I made on this subject are not extensive; but as they were conducted with care, they may serve to give a very just idea of the absolute force of horses of middling strength. For this purpose I employed four horses of middle size, in good health and well-conditioned, which were subjected separately and in succession to the same trial. The first drew equivalent to 36 myriagrammes; the second $38\frac{1}{2}$; the third $26\frac{1}{2}$; and the fourth 43. The sum of all these is 144 myriagrammes; and if we take the mean of this sum, we shall have, for the strength of ordinary horses, 36 myriagrammes, or 736 pounds *de marc*.

XII. Method of filling up Engraving on Silver with a durable Black Enamel, as practised in Persia and India.

Communicated in a Letter from Siberia to Professor PALLAS.

From Neue Nordische Beytrage, Vol. V.

I AM now acquainted with the secret of our silversmiths for filling up the engraving in plate with a black, glassy, durable mass, respecting which we have so often conversed; and it is very singular that the Russians must have derived this process from the Persians and the Indians.

They take half an ounce of silver, $2\frac{1}{2}$ ounces of copper, $3\frac{1}{2}$ ounces of lead, 12 ounces of sulphur, and $2\frac{1}{2}$ ounces of sal ammoniac. The metals are melted together and poured into a crucible, which has been before filled with pulverised sulphur made into a paste by means of water; the crucible is then immediately covered that the sulphur may not take fire, and this regulus is calcined over a smelting fire until the superfluous sulphur be burnt away. This regulus is then coarsely pounded, and, with a solution of sal ammoniac, formed into a paste, which is rubbed into the engraving on silver plate. The silver is then wiped clean, and suffered to become so hot under the muffle, that the substance rubbed into the strokes of the engraving melts and adheres to the metal. The silver is afterwards wetted with the solution of sal ammoniac, and again placed under the muffle till it becomes red hot. The engraved surface may then be smoothed and polished without any danger of the black substance, which is an artificial kind of silver ore (*fablerz*), either dropping out or decaying. In this manner is all the silver plate brought from Russia ornamented with black engraved figures, &c.

XIII. *Different Methods employed in Encaustic Painting, according to the Principle followed by the ancient Greek and Roman Painters, discovered by the Abbé REQUENO, and since practised with much Success at Rome.* Communicated by Mr. CHARLES HEATHCOTE TATHAM, Architect.

THE following receipt for painting in *encausto*, copied from an original paper, was presented to Mr. Tatham, at Caserta near Naples, by Mr. Philip Hackert, painter to his Neapolitan Majesty. It exemplifies the mode supposed to be practised by the ancients in their arabesque. After this manner a large bath was decorated in a casino of the king of Naples at Belvidere near Caserta, the walls and vaulted cieling of which were entirely covered with encausto, under the direction of Mr. Hackert, who was so obliging as to accompany Mr. Tatham to visit the success of it, which he did, much to his satisfaction, when upon his travels in the year 1795.

The first preparation is as follows: Infuse a pound of gum tragacanth * in a proportionate quantity of water, for twenty-four hours, in an earthen vessel. When this solution is pretty thick, add to it mineral colours of any sort, broke into pieces without being pounded, and which must afterwards be prepared in the following manner:

Put an ounce of white wax and an ounce of gum tragacanth into a small earthen vessel well glazed, together with two or three pounds of water, and keep the vessel over a brisk fire, that the ingredients may become liquid, stirring them continually with a small stick. When the whole are well dissolved, take the vessel from the fire, and, after the liquor has cooled, skim off the wax from the surface. The oily parts of this wax are left in the gum water, which must be afterwards strained through a piece of linen cloth. This liquid and the colours prepared

* Commonly called gum dragon.

with it may be kept several months, in bottles closely stopped, after a little brandy or spirit of wine is added to it, and will be good even at the end of several years.

The colours moistened with the solution of gum tragacanth must, for the greater convenience, be ground with pure water, and afterwards with the above-mentioned preparation, till they become exceedingly fine; and they may then be employed for painting all sorts of figures or landscapes in arabesque, in the manner of distemper or *de gauche*. When they are perfectly dry, they are then covered with white liquid wax, warmed by burning coals placed in a chaffing-dish: when the wax begins to melt, it is spread out by means of a badger-hair brush, to render it every where equal; and when cool, a polish and lustre are given to it with a proper rubber or piece of soft cloth.

The second method of preparation, which was found more convenient, is the following: Having put an equal quantity of white wax grated and of gum arabic in an earthen vessel, with as much water as may be necessary to render it more or less thick, according to pleasure, the same process is then to be followed as in the preceding case: the colours must be finely ground with this mixture, and may then be employed for painting.

These two preparations were employed with great success, for three years, to paint various pictures, decorations and ornaments, ordered by the empress of Russia; and the transparency of the colours produced a most brilliant effect. In the beginning of the year 1791 the three ablest artists in *encausto*, M. dell' Era, in the historical line; M. Campovecchio for landscapes; and M. Vincent Angeloni for arabesque ornaments, used them with a very happy effect, and the pieces they produced were not inferior in lustre and brilliancy to the finest paintings in oil mixed with varnish. Several trials were made in this way on walls, wood, cloth, paper, copper, and marble; and it was found that paintings on the latter substances could be washed by means of a sponge

dipped in water, but that too strong friction penetrated to the colours, and carried off a part of them. Paintings on walls or wooden pannels resisted friction much better; but if the hand pressed too hard, some of the colour was destroyed, especially in places to which the liquid wax had not sufficiently penetrated.

To prevent these inconveniences, trial was made of other preparations, pointed out before by the Abbe Requeno, agreeably to several passages of Pliny and Vitruvius. These trials were perfectly successful, and paintings executed with the preparations, as hereafter mentioned, resisted much better friction with a wet sponge. The mechanism even of painting in this manner, with these colours, was found more convenient and much easier, because the colours did not dry so speedily as those prepared in the first and second manner.

The preparation of colours agreeably to the last method is as follows: Take a vase of vitrified earth, and place it over a small fire with an ounce of white wax; and when the wax is melted, add four ounces of olibanum (*incenso maschio*,) reduced to powder, which must be also dissolved with the wax. This mixture must be put into a small vessel with water, and you will obtain a hard brittle crayon, which must be mixed with the colours when ground up.

The same process may be followed with mastic, by taking five ounces of that substance and two of wax, and this crayon will serve for the brighter colours. For darker colours the crayon may be made of four ounces of asphaltos and two ounces of wax.

Method of making Dislemper for preparing the Colours.

Infuse, for twenty-four hours, a pound of the gum of the cherry-tree, and, when it is dissolved, put it into a small earthen vessel, and boil it with two ounces of wax and half an ounce of olibanum reduced to a fine powder. When this liquor is cool, take off the wax which floats on the top,
and

and then mix the liquid with the colours, in order to render them more oily and fluid. Care must be taken that this preparation be a little thick.

XIV. *Chemical Observations on the Epidermis.* By J. A. CHAPTAL. From *Annales de Chimie*, Vol. XXVI.

THE epidermis of the human skin is perhaps the best expanded and the easiest to be detached of any, and for that reason I made it the subject of the following experiments.

The human skin becomes shrivelled in hot water, and divides itself into two distinct parts, the *epidermis* and the *cutis*. The latter resembles then in its consistence a softened cartilage. The continued action of warm water at length dissolves the cutis, but does not sensibly affect the epidermis. Alcohol kept a long time in digestion on the epidermis likewise produces no effect. Caustic alkali dissolves it, and the same effect is produced by lime, though more slowly. There is then an analogy between the external covering of the human body and that which covers silk. From these observations we are authorised to deduce the following consequences, which may be applied, without overstraining the principle, to the operations of tanning. 1. If we plunge into a tanning infusion a piece of skin covered by its epidermis, the tan penetrates only on the flesh-side: the other side is secured from it by the epidermis, which is not susceptible of any combination with the tanning principle.

2. When the epidermis is removed by the operation of liming, the tan then penetrates on both sides of the skin.

3. Lime, which is generally employed for taking off the hair, seems to act only by dissolving the epidermis. Lime-water has more action than undissolved lime; but its effect ceases the moment that the small quantity of lime held in solution is combined with the epidermis: hence the necessity of renewing the lime-water till the whole effect required be produced.

XV. *Of a remarkable Cure effected by the Use of Carbonic Acid Gas, communicated in a Letter to his Excellency Prince Demetrius de Golitzin, Minister of the Imperial Court of Russia at the Hague. By M. D. JANSSENS of Oosterhout. From the New Transactions of the Imperial Academy of Sciences at Petersburg, Vol. I.*

Oosterhout, Nov. 23d, 1778.

IN the conversation I had the honour of having with your Excellency on the medical virtue of carbonic acid gas; or fixed air, I promised to give you an account of the effects it might produce in the putrid fever, by being injected into the rectum; but though in the following case, which is certainly very uncommon, I have not exactly followed the method pointed out by your Excellency, having been obliged to give as much of the cinchona or Peruvian bark as possible, I however believe that it greatly contributed to the cure.

The wife of a bargeman at G. Berg, named N. Swart, aged thirty-two, of a sanguine temperament and a sound constitution from the time of her birth, was attacked, after her third natural delivery, according to every appearance a favourable one, which happened on the 6th of October at two o'clock in the morning, with a fever that began on the 8th. It may be right to premise, that on the 6th she was exceedingly well, and her evacuations were perfectly free.

On the 7th they flowed less, and she began to complain of lassitude, a great heaviness in all her limbs attended with a loss of appetite, and the disappearance of milk from her breasts. At the commencement of the third day the evacuations were stopped, and the fever came on by cold and successive fits of shivering with reaching and pain in the head, which was not acute, but accompanied with a sensation like that of a weight pressing on the cranium, and from which she suffered less when in bed than when sitting up. These symptoms were followed by a great heat, with vomiting of a bilious, greenish, highly corrupted stuff: her tongue

was covered with a viscous matter of a yellowish colour the two first days, but it was afterwards brown till the 6th.

Her breathing was short, oppressive, and accompanied with a fetid smell. The pulse, which was weak, beat from 90 to 94 in a minute. The heat was not examined by a thermometer. The urine was red and fetid, without sediment. The patient had a violent thirst, and drank a great deal of whey with lemon juice.

On the second day of the fever she was affected with delirium, coma, restlessness, and a dread of death. On the third all these symptoms increased. On the fourth there was an involuntary discharge of urine, &c. On the fifth there came on a diarrhoea of a bilious and putrid matter; and the delirium being then continual, she suffered every thing to escape her. On the sixth the symptoms were no better. On the seventh the tonsils were white, and this thickened secretion, at length, covered all the parts of the mouth; deglutition became difficult, there was subfultus tendinum, and the patient with her trembling fingers picked the blankets. On the eighth all the symptoms were as before, with vibices half an inch in diameter, which rose in small blisters, and appeared on the breast, the hands, and other parts of the body. On the ninth these blisters discharged blood, for the most part thin and corrupted, the ground of which was in some a brown purple, and in others red. The cheeks were also of a brown purple colour, the eyes hollow, and the pupils much dilated. At last a cold sweat broke out on the face, the hands and feet; the mouth quivered, and the cheeks, lips, and all the members of the body were slightly convulsed.

All these bad symptoms gave reason to be apprehensive for the life of the patient; but the pulse continuing regular gave me some hope. While the patient was in this condition, being called in to consult with the physician who had treated the case according to the rules of the art, I advised the application of carbonic acid gas by the rectum, together

gether with the following decoction: Twenty-five grains of salt of tartar (carbonat of potash) dissolved in five ounces of a strong decoction of bark. I gave five ounces of this decoction, in which I had put as many drops of spirit of vitriol (sulphuric acid), to extricate the fixed air.

This injection was given twice the two first days, and only once daily for the three following.

In regard to medicine, the patient took every hour, in a cup-full of tea, the following decoction: Cinchona or bark in a coarse powder, four ounces, digested in a sufficient quantity of common water for three hours, till reduced to two pounds. I dissolved in a pound of this decoction a grain of salt of tartar, to which I added the other pound, into which I had put as many drops of spirit of vitriol as were necessary to saturate the alkali, and disengage the carbonic acid gas*.

On the tenth day all the symptoms were the same, except that the sweats were less cold. On the eleventh they were still less so; and perspiration proceeding equally from every part of the body, the tonsils began to look better, deglutition was not so difficult, and the delirium was not so continual. From time to time the patient was collected, and called for the urinal.

The twelfth and thirteenth she was still much better; the colour of the cheeks was almost natural, and the vibices became of a brighter red; the convulsions ceased, and all the other symptoms had almost disappeared. On the fourteenth a perfect crisis took place in regard to the urine and perspiration. On the fifteenth the patient felt no more fever, and had no symptom of disease except great debility; so that on the twentieth day she was perfectly re-established.

During the course of the disease her breasts were flaccid and very small, without milk; but having visited her on the

* This does not appear to be the best method that might have been devised for introducing the carbonic acid gas. In fact, the greatest part of that extricated from the carbonat would be thrown off at the moment of joining the ingredients. *Epit.*

tenth of November, I saw milk issue from her breast; and, as she had almost recovered her strength, I advised her to let her infant try to suck, and the milk was restored.

I have been particular in detailing this case, that your Excellency, from the circumstances both of the nature of the disease and of its cause, which was probably a stoppage of the floodings after delivery, might the better be enabled to judge of the medical virtue of carbonic acid gas; and, at the same time, to see the reasons I have had for varying the application. I was afraid of a putrefaction or universal gangrene; against which I prescribed bark; and as the latter could not prevent the extrication of the carbonic acid gas, I added the substances necessary to produce it.

XVI. *Extract of a Memoir on the Fossil Bones of Quadrupeds. By Cit. CUVIER. From Bulletin des Sciences, No. XVIII.*

THE author's object in this memoir was to collect, as far as possible, every information respecting the various kinds of fossil bones hitherto found, whether seen by himself or described by others; to examine the skeletons, and to compare them with those of animals now existing on the globe, in order to determine how far they are similar or different. The following are the kinds which he examined:

1. The bones and tusks called by the Russians the bones and horns of the mammoth. Such fossil remains are found in various parts of Europe. This animal is a kind of elephant nearly resembling that of Asia, but differs from it in the alveoli of its tusks being longer; that the angle formed by its lower jaw is more obtuse, and that the laminae of which its grinders are composed are thinner. A living animal really analogous to it is not known, though it has hitherto been considered as a common elephant.

2. The

2. The remains of an animal which have been found on the banks of the Ohio in North America, and which the Americans and the English consider as those of the mammoth also, though this animal is very different from the preceding. Remains of it are found also in Europe and Asia. It must be almost of the same height as the elephant, but more bulky. Its tusks are smaller; its grinders are armed with large cutting points, the section of which presents, when they are worn down, double transversal lozenges. There are three grinders on each side; one of which has four points, the second six, and the other eight.

3. The animal, the teeth of which tinged by copper furnish the turquois. Of these fossils there was a mine at Sinore in Languedoc. Remains of the same kind are found in the department of Ain, in Peru, and other places. This animal must have resembled the preceding; but the points of its grinders are of a conical form, and, when worn down, their section presents, first a circle, then a semi-oval, and then the figure of a trefoil; which has made them be confounded with the teeth of the hippopotamus. Some of these teeth have twelve points, others six, and others four.

4. The hippopotamus. There are found in France, and other countries, teeth and the fragments of jaw bones, in which the author has never yet been able to discover any thing different from those of the common hippopotami. As he never saw, however, a whole bone, he cannot affirm the identity.

5. That species of rhinoceros with an elongated cranium, the bones of which are found in Siberia, Germany, and other countries. The author has seen teeth and portions of the jaws found in France, which appeared to him to belong to this animal. The principal characterising mark of this species consists in the osseous partition of the nose. A living animal analogous to it is unknown.

6. A grinder with two transverse eminences, in the possession of Cit. Gillet, and of which a germ is preserved in the National Museum. It has no resemblance to the teeth, nor to the germs of the teeth, of any animal, whether living or in a fossil state, hitherto known. The only teeth to which it bears a resemblance is the last lower grinder of the rhinoceros. This tooth indicates, then, the existence of a sixth fossil species analogous to no living animal known.

7. The animal, twelve feet in length and six in height, the skeleton of which was found below the earth in Paraguay, and is now preserved in the Cabinet of Natural History belonging to the king of Spain at Madrid. By a minute comparison of the bones of this skeleton with those of all the known quadrupeds, the author proves that it is a peculiar and distinct species, which approaches nearer to the sloth than to any other kind, and that it might be named the giant-sloth. Cit. Cuvier here mentions, occasionally, an interesting discovery he has made, that the aï, or three-toed sloth (*bradypus tridactylus*, LIN.) has naturally and invariably nine cervical vertebræ. This is the first known exception to the rule established by C. Daubenton, that all the viviparous quadrupeds have neither more nor less than seven cervical vertebræ.

8. The animal, remains of which are found in the caverns near Gaylenreuth and Muggendorf, in the margraviate of Bayreuth in Franconia. Several have considered this animal as a sea-bear; but it differs from it, as well as from all the bears known, in the form of its head, characterised above all by the projection of the forehead; the want of the small tooth, which the bears hitherto known have behind each canine tooth; by the osseous canal of the humerus, through which the tracheal artery passes; and by several other circumstances in the figure and proportion of the bones. It is however to the bear that this animal has the greatest affinity.

9. The carnivorous animal, bones of which are found in

the plaster stone of Montmartre. The form of its jaw-bones, the number of its grinders, the points with which they are armed, indicate that this species must belong to the genus of the canis. It however does not exactly resemble any known species of that genus. The most striking distinctive mark is, that the seventh lower grinder is the greatest in the animal of Montmartre; whereas it is the fifth in the dog, wolf, fox, &c.

10. The animal, a lower jaw of which, found near Verona, has been considered by Joseph Monti as a portion of the cranium of the sea-cow; an opinion adopted by all geologists, though contrary to the simplest principles of comparative anatomy. This jaw, according to Cit. Cuvier, has belonged to an animal approaching near to the mammoth, the animal of the Ohio, and that of Sinore, though specifically different. Its most particular characterising mark consists in the beak formed by its symphysis.

11. The animal of the stag kind, bones and horns of which are found in Ireland, England, at Maestricht, &c. It is evidently distinct from all the stags known, and even from the elk, to which it has been referred, on account of the enormous size of its horns, the flatness of the upper part of them, and the branches that arise from the root. Several figures of them may be seen in the Philosophical Transactions.

12. The genus of the ox alone furnishes several species of fossils. The skulls of two which have been described by Pallas, were found in Siberia. One of these he referred to the common buffalo; but he afterwards referred it to a particular species named arni, originating from Thibet. Cit. Cuvier proves, by osteological comparison, that this skull does not belong to the buffalo. The other kind appeared to Pallas to belong to the buffalo of the Cape, or the musk-ox of Canada. Cit. Cuvier shews that they could not have belonged to the former; but, not having the cranium of the arni nor the musk-ox, he does not speak with certainty of their identity or non-identity with these fossil crania.

The

The author describes, also, two sorts of crania found in the mosses in the department of La Somme, and which have a great resemblance to those of the urus, which are nearly one fourth larger.

Cit. Cuvier concludes his researches as follows: 1. It is not agreeable to truth to assert that the animals of the south have formerly existed in the north, their species not being perfectly identic. 2. That there have existed in all countries animals which do not exist at present, and that are nowhere to be found in any known part of the globe. He therefore leaves it to geologists to make such changes or additions, in regard to their systems, as they may think necessary to explain the facts which he has thus established.

XVII. *Observations on the Constituent Parts of Atmospheric Air.* By Count de MOROZZO. With the Remarks of F. VAN HUMBOLT. From the Journal de Physique, Fructidor, 6th Year.

IN the memoir which I published in 1784, on animal respiration in dephlogisticated or oxygen gas, I offered some reflections respecting the constituent parts of atmospheric air, founded on experiments I had made. Lavoisier, in his Elementary Treatise of Chemistry, does not agree with my experiments. That author says, that the component parts of atmospheric air are 73 parts of mephitic or azotic gas, and 27 of oxygen gas, eminently respirable. It will then be seen, adds he, that when animal substances are dissolved in the nitric acid, there is disengaged a great quantity of gas, which extinguishes a lighted candle, injures animals, and which has a perfect resemblance to that part of atmospheric air which is unfit for respiration. If to 73 parts of this fluid we add 27 of oxygen gas, obtained from mercury reduced to the state of an oxyde by calcination, there is formed a

fluid perfectly similar to that of the atmosphere, and which has all its properties.

The following, on the other hand, are the corollaries which I have deduced from a great number of experiments made to ascertain the duration of animal life in noxious aeriform fluids, mixed in different proportions with oxygen gas, tending to illustrate the real composition of atmospheric air.

1. The examination by means of burning tapers is not accurate for ascertaining the salubrity of the air. I shall quote only two examples. A fifth part of oxygen gas mixed with air contaminated by the vapour of sulphur, suffered a candle to burn, while an animal shut up in it died in a few seconds. A seventh part of the same gas mixed with air vitiated by the vapour of charcoal, supported flame, while an animal died in it almost instantaneously.

2. That pure and salutary part said to be contained in atmospheric air, which forms a third of it according to Scheele, and a fourth according to Lavoisier, is not a real dephlogisticated oxygen gas; since this gas united with mephitic airs, in a much less proportion than a third or fourth, supports the flame of a candle after an animal dies in it, which is not the case with atmospheric air.

3. The real component parts of atmospheric air are still unknown; since, with a mixture of different gases, nothing has been obtained but compound gases, which have indeed some properties of air, but never those of atmospheric air.

The author, to illustrate the question, relates eight characterising marks of atmospheric air, acknowledged by philosophers; and adds, that though he tried, by a multitude of experiments, to compose atmospheric air, by mixing dephlogisticated gas with different mephitic gases, the gases so obtained always contained something not to be found in atmospheric air.

He repeated the experiments of Lavoisier, by mixing 73 parts of fixed air (carbonic acid gas), obtained from lime, with 27 of gas obtained from the red precipitate. This mixture, indeed, exhibited to him all the characters and properties of atmospheric air, but it differed considerably from it in its essential property.

A candle is suddenly extinguished in atmospheric air in which an animal has died; another animal could not live in it an instant. On the other hand, in this artificial mixture, a flame burnt with vivacity; and a second animal, a sparrow, lived 25 minutes, a third 14 or 15: a light, introduced after the death of the third sparrow, burnt still with a bright flame. "*This mixture then does not form an elastic fluid perfectly similar to that of atmospheric air, and having all its properties.*" He tried to add to this mixture phlogisticated gas, inflammable air, and that in which an animal had died. A second and third animal lived in them some time, and a candle was not extinguished.

Remarks on the above Observations, by F. Von Humbolt.

The memoir of Count Morozzo treats of a very important subject, with which I have been engaged for some months. The Italian philosopher has observed the difference between natural atmospheric air and an artificial compound of azot and oxigen; but, in my opinion, he goes too far, in asserting that atmospheric oxygen is not vital gas; though I agree with him that we are not able to form an aeriform fluid, such as the illustrious Lavoisier announces in his Elements of Chemistry, perfectly similar to that of the atmosphere. I however find that this difficulty consists neither in our ignorance of the *quantity*, nor of the *quality* of the two gaseous bases. The difference found between the effect of natural and artificial atmospheric air, is to be ascribed to the *state of the combination* in which the oxygen is joined to the azot. The atmosphere is not a *mixture*: its constituent parts ought to be considered as in a state of *chemical combination*.

nation. It is for this reason that the two bases of a specific gravity so different, that of azot and that of oxygen, do not entirely separate from each other, though the high regions are most charged with azot. Hence azot retains so strongly the last portion of the oxygen, which phosphorus, the sulphure of potash, and other acidifiable bases ought to take from it; and I have for this reason seen that the nitrous gas acts in proportions very different in decomposing the natural atmospheric air, or a compound of 27 of oxygen and 73 of azot. But how could Morozzo think to imitate the atmosphere by mixing the carbonic acid and oxygen? He has confounded azot with the carbonic acid gas. But he assures us that his atmospheric air with a carbonic acid base, gave the same specific weight as atmospheric air. Here is a very striking experiment: one cubic inch of azot weighing 0,46624 grains, while the same cubic inch of carbonic acid weighed 0,67500 grains! Morozzo tells us that a candle burnt in his artificial mixture with a very brilliant flame (*con fiamma lucidissima*). By combining 0,25 of the carbonic acid with 0,75 of oxygen, I have seen a wax taper extinguished. The same thing took place when in company with Tasseart in Vauquelin's laboratory, I mixed two parts of the carbonic acid gas with ten parts of atmospheric air. There is then formed a new chemical combination: the carbonic acid lays hold so strongly of the oxygen of the atmosphere, that the affinity presented by the lighted wax taper is not powerful enough to take it away. In my work on the analysis of the mephitic vapour of mines, which is about to be translated into French, it will be seen that there exists airs not unfit for respiration, which are composed of 0,27 of oxygen, 0,70 of azot, and 0,03 of carbonic acid gas. It is the state of the combination, and not always the quantity of oxygen, which renders air more or less capable to destroy animal life, or to extinguish flame.

XVIII. *Curfory View of fome of the late Discoveries in Science.*

[Continued from the laft Number, page 309.]

LUMINOUS FLUID.

THERE are two principal opinions entertained by philofophers refpecting the nature of the luminous fluid. Some, with the fchool of Epicurus, think that this fluid is a continual emanation of the luminous body which throws to a diftance a portion of its fubftance. This is what is called the emission of light, and was the opinion adopted by Newton.

Others, among whom is Euler, think that the luminous fluid is diffufed throughout infinite fpace, and that it is acted upon by the luminous bodies as the air is by fonorous bodies. This opinion appears to Cit. de la Metherie much more probable than the former.

One of the ftrongeft objections made to this opinion is, that light is never propagated but in a ftraight line. Objects cannot be feen, except when no opaque body is interpoled between them and the eye, whereas founds are heard in every kind of direktion. Euler replied to this, by faying, that bodies are permeable to founds. Befides there are circumftances where founds alfo cannot be propagated but in a right line; for example, in echoes which are heard only in a very fmall fpace.

Chemifts likewife are divided in their opinions refpecting the luminous fluid. Some believe it to be an elementary fubftance, and others have confounded it with fire. Richter believes that it is compofed of the inflammable principle and caloric.

Benedict Prevost has endeavoured to eftimate the gravity of the luminous fluid. He made to float on water very thin round plates of tin, and thefe bodies were repelled when a cylinder of red hot iron was prefented to them obliquely at fome diftance, or when the rays of the fun collected into a

focus by a lens were made to fall upon them. Prevost is of opinion that the rays of the sun penetrating the tin-plate are thus combined with a matter more dense, and form therein a very expansible fluid; but being less subtle, it becomes susceptible of acting by impulsion on very large masses, and issuing with impetuosity from the plate, but more rapidly from the focus, pushes it backwards, and pursues its way through the water, which acts as a conductor to this fluid.

The author conjectures, from these experiments, that it is possible to determine the gravity of light. It is well known that it takes about eight seconds to come from the sun to the earth, that is to say, to traverse a space of about thirty-three millions of leagues. According to some suppositions, he finds that the light which in a second of time falls upon the surface of a square league, containing 2,283 toises on each side, would weigh about a dram (*gros*) and a quarter. It may be readily perceived that all these calculations are very hypothetical; and we may add, that from some experiments made by Professor Wilson of Glasgow*, with a view to a different object, there is reason for calling in question the effect produced upon the thin plates, or tin foil, as being at all produced by the impulse of light. Heat only seems to be here concerned. The water at first being of an uniform temperature, has all its parts in a state of equilibrium and rest. When the tin foil is heated, it is evident that a very active cause is introduced tending to destroy that equilibrium. Heat being communicated by the tin to the water in contact with it, that portion of the water endeavouring by its expansion to move from under the tin, must tend to move the tin from its place.

[To be continued.]

* See the Professor's experiments on small lighted wicks floating on oil, inserted in the *Edinburgh Transactions*, Vol. IV. See also Count Rumford's Experiments on Heat.

XIX. *Communication from Dr. THORNTON, Lecturer on Medical Botany at Guy's Hospital, respecting a suppositæ Lufus Naturæ now exhibiting in London.*

IN the first volume of the Philosophical Transactions, No. XXIX. published November 1667, you have the following communication, entitled,

“Some Hortulan Experiments about the engrafting of Oranges and Lemons or Citrons, whereby is produced an individual Fruit, half Orange and half Lemon, growing together as one Body upon the same Tree.”

We have here orange trees (saith the intelligence from Florence), that bear a fruit which is citron on one side and orange on the other. They have been brought hither out of other countries, and they are now *much propagated* by *engrafting*. This was confirmed to us (says the Editor of the Transactions of the Royal Society), by a very ingenious English gentleman, who asserted, that himself not only had seen, but bought of them, anno 1660, in Paris, whither they had been sent by Genoa merchants; and that on some trees he had found an orange on one branch, and a lemon on another branch, (which is not so remarkable as what follows;) as also, one of the same fruit, half orange and half lemon; and sometimes three quarters of one, and a quarter of the other.

In the third part of the Reports of the Board of Agriculture, among the foreign communications, we see, with equal pleasure and astonishment, an account of the American apple, which, by a peculiar mode of budding*, is half sweet and half sour, half white and half red, without the least confusion of the respective halves.

At Mr. Mason's, florist, Fleet-street, opposite the Bolt and Tun, there is a production now to be seen half peach and half nectarine. It has all the softness and yellow down of

* The manner in which the extraordinary nectarine-peach first produced in this country was effected, was by inserting the bud of one fruit upon the stock bearing a different sort.

the peach, and the sleek red smoothness of the nectarine; supposed to be a *lufus naturæ*, but probably is rather the sportings of art, than of nature, and which perhaps will be the cause why we shall in future see many other such vegetable wonders, which, as I have shewn, were known to our ancestors.

Respecting my promised communication concerning the silk-worm, I must beg leave to delay it, until I have ascertained for certain the difference of the Chinese, from the mulberry trees, cultivated here; the former being, I have reason to believe, only a shrub, with a very broad leaf, and dying down to the ground every year, springing up the next.

INTELLIGENCE.

LEARNED SOCIETY.

THE directors of the Imperial Academy of the Searchers into Nature, have proposed the following questions as subjects for prizes.

I. In which of the known parts of vegetable productions, the bark (*cortex*), inner bark (*liber*), wood (*alburnum et lignum*), pith (*medulla*), does the sap ascend? Does a reflux of the sap towards the root, proportioned to the ascent, take place in the bark or the pith, or in both? And, if this be the case, by what way is it conveyed from the interior parts to the bark? What course does it, in particular, take to pass through the leaves to the bark?

The Academy wishes, in particular, that the motion of the sap in the bark upwards may be proved or refuted; both by a careful repetition, varying the circumstances, of the experiments which have already been adduced as a proof of it, and by a sufficient number of well chosen and appropriate new experiments. The best founded experiments, which prove the ascent of sap in plants, have been enumerated by Duhamel, in *Physique des Arbres*, b. v. chap. 2, art. 7—11,

and the most important of them are as follows: 1. If a plant is suffered to imbibe a coloured fluid, it ascends in the vessels between the pith and the bark, penetrates to the leaves, and then proceeds through the bark a certain space downwards. 2. When a plant or a twig is compressed at the bottom by a ligature, a swelling takes place upwards towards the ligature. 3. When the bark of a tree is taken off, without injuring the interior part, the upper edge of the wound produces a greater quantity of moisture than the under. 4. Under these circumstances an excrescence is formed on the upper part of the bark, and not on the under; and the renovation of the inner bark, which has been lost, takes place from the top downwards.

II. What beneficial use may practical medicine derive from Humboldt's well known experiments on Galvanism and metallic irritation?

The Academy expects that the diseases and cases, in which Galvanism may be useful, will be accurately determined by proper experiments; and that the experiments will be clearly and fully described. Experiments, however, on persons apparently dead, are to be omitted.

The Academy requests all answers to these questions, if founded on experiments actually made by the authors, to be legibly written in Latin; to be inscribed with any motto according to pleasure; and to be accompanied with a sealed note, having on it the same motto, and containing in the inside, the name, title and place of residence of the author; and to be transmitted, before the first of October 1799, to the president of the Academy, G. H. R. von Schreber at Erlangen.

The prize, for each question, is a gold medal of twenty ducats value, bearing the usual impression, and will be adjudged to the author of the best papers, by the commissioners of the Academy, on the 5th of January 1800.

MAGNETISM.

WENZEL has proved that cobalt is susceptible of magnetic attraction, and has magnetic poles. Klaproth has proved that the purest nickel, that even of the *Chrisoprasus*, is also susceptible of the same attraction, and has magnetic poles. The serpentine of Humboldt has magnetic poles, but does not attract iron. The case is the same with several sorts of lava. Here then are bodies which have polarity, without attracting iron. Are there bodies which act upon iron without having polarity? Tralles, a geometrician of Berne, has taken very small fragments of Humboldt's serpentine, which had very perceptible poles, and having placed them close to very strong magnets, the poles of which were opposite to those of the serpentine, the poles of the serpentine became inverted.

MINERALOGY.

Several mineralogists think that the metallic veins in mines diminish always in thickness the deeper they proceed; so that these veins resemble a kind of wedge, the base of which is directed towards the surface of the earth, and the point towards the centre. But this is not precisely the case. Several veins appear indeed to be of that form; but there are many others, the form of which is quite the reverse. Humboldt says that the vein of *Kuhchacht* at *Freyberg*, which contains argentiferous galena, grows broader, instead of becoming narrower, the deeper it goes; and yet it is one of the deepest worked, as it proceeds to the depth of several hundreds of fathoms. Those of *Goldernach* in *Franconia*, which contain arsenical and auriferous pyrites, are much broader at a certain depth than at the surface.

COLD PRODUCED BY COMPRESSED AIR.

Those machines employed for strongly compressing atmospheric air are well known. Professor *Pictet* of Geneva says,

says, he has seen this air, thus compressed, produce a very great degree of cold when the cocks were opened to suffer it to escape. To demonstrate this in an easy manner, let a small quantity of water be put into a compressing machine. When the air escapes, it issues with a hissing noise, and carries with it a part of the water; and at the end of the operation, the water adhering to the cock, will be found converted into ice. To explain this phenomenon, we may suppose that a portion of the water, which is carried off by the air, is reduced to an aeriform state, or that of vapour. But this could not be the case, unless a pretty considerable quantity of caloric were combined with the vapour. The remaining drops of water are therefore sufficiently deprived of it to be congealed. It is in the same manner that the rapid evaporation of ether, applied to the ball of a thermometer, makes the liquor speedily descend several degrees.

PHYSIOLOGY.

Dr. Sæmmering has proved, by a great number of observations, that the degree of intelligence of different animals is always in proportion to the bulk of the brain, compared with that of the nerves. Man has the most voluminous brain, and his nerves are very small: it is this which gives him his high degree of intelligence. The ass has very large nerves, and a very small brain. Dr. Ebel has published on this subject a very interesting dissertation, which we hope soon to be able to lay before our readers.

GRAVITY OF WATER.

Bodies are dilated by warmth, and consequently become specifically lighter the hotter they are. On the contrary, they are contracted by cold, and become so much denser the colder they are. But this law of condensation is subject to some exceptions: melted metal, for example, dilates to a certain degree as it becomes solid; water experiences the
same

same dilatation in congealing. To find then the greatest specific gravity of water, we ought not to take ice, for we know that it swims on water. We must make choice of a certain degree of heat between that of congelation and that of expansion. Experience has determined this point to be about 41° of Fahrenheit. Consequently, to find the greatest quantity of water which can be contained in a vessel of a given capacity, we must take water at that temperature.

This circumstance should be attended to in determining measures of capacity. Some people are so well aware of it that they buy liquids in cold, and endeavour to sell them in hot weather.

METEOROLOGY.

On the 10th inst. about twelve o'clock at night, a remarkable meteor was observed by one of the masters of the Free-school at Alnwick, and another person; it appeared in the south-west, at a considerable altitude. At first it was no bigger but far brighter than a common star, but presently expanded into the form and size of an apothecary's pestle. It was then obscured by a cloud, which was still illuminated behind; when the cloud was dispelled, it re-appeared with a direction south and north, with a small long streamer, cutting the pestle a little below the centre, and issuing away to the eastward. It was again obscured, and on its re-appearance, the streamer and pestle had formed the figure of a hammer, or a cross; presently after the streamer, which made the shaft to the hammer, or stalk to the cross, assumed two horns, at the extreme point towards the east, resembling a fork. It was then obscured a third time, but when the cloud passed over, it was changed into the shape of two half-moons, back to back, having a short thick luminous stream between the two backs; it then vanished totally from their sight. It is observable, that every new appearance became brighter and brighter, till it became an exceedingly brilliant object, all the other stars in comparison appearing to be

be only dim specks. The time of observation was above five minutes.

The *Decade Philosophique* contains an account of a singular phenomenon which was observed on the 19th of August last, at Caumont, principal town of the district, at the extremity of the department of Calvados.—“The weather was fine; a few light clouds scattered here and there in the sky. The atmosphere was loaded with vapours, the wind North West, the barometer at 28 and a fraction, and Reaumur’s thermometer at between 18 and 19 degrees, about 72° of Fahr. A circle of white clouds was formed about the altitude of the sun, passed through its centre, stretching uniformly to the same height in a horizontal plane. This circle, or belt, in its greatest breadth, was nearly the size of the sun’s semi-diameter. On this circle were projected two parhelia or disks nearly of the same size as that of the sun, from which they were at equal distances; the one at the right, the other at the left, at the distance of about 45 degrees each from the sun. In each of these disks, the part opposite to the sun was very luminous, to the extent of nearly three parts of their diameter, and presented prismatic colours. The rest was nebulous (that part next the sun). At about 110 degrees from the sun on each side, appeared two other disks traced upon the same circle at equal distances. But they were perfectly of the same whiteness with the circle, and were not quite round. A semicircle rose above the sun, and formed an arch, the cord or base of which was a section of the great white circle, the centre of which was the sun. The radius of this semicircle was about 22 degrees, and terminated on each side of the sun nearly at half the distance of the sun from each of the luminous disks. This semicircle uniformly contained a vapour of a clear brown, the extremities of which, without any shade, ran into the surrounding atmosphere. This phenomenon continued for nearly an hour. The circle began to fade on the North side, where

where it never had been so clearly marked out. The luminous disk disappeared last.

“These observations were made by a great number of people, as it was market day in the place. As prejudices are still very strong in most parts of the country, every one reasoned according to his religious or political prejudices—Some said that it was a sign of the anger of God against the changes which had taken place: others, of an opposite opinion, said that God had crowned the republic: others again thought that the great circle which seemed to embrace all this hemisphere, announced a general peace.” The writer of the account concludes, “I had no great difficulty in persuading the majority that these signs were the effect of the vapours and exhalations occasioned by the heat. Ten years ago I should not have been so successful.”

DYEING.

Cit. Chaptal, having been lately engaged in examining the causes of the fixity of certain yellow colours, has observed, that the yellow colour extracted from vegetables is in general in the inverse ratio of its splendour. He has endeavoured to ascertain the cause which renders the pale yellow more durable, and has discovered it in the existence of the tanning principle, which is found united with the yellow principle in most vegetables. By analysing fustic (*morus tinctoria*) he obtained, 1st, a principle partaking of the nature of resins or gums, and which can communicate a beautiful yellow colour; 2d, an extractive principle, which is also yellow, and furnishes a beautiful colour; 3d, a tanning principle, of a pale yellow colour, which grows black in the air and by ebullition—it tarnishes the colour of the other two principles. As it was necessary to separate the tanning principle, in order to leave to the rest the full vivacity of their colour, Chaptal found means to accomplish that object by a simple and cheap process. He boiled, with the wood, some animal substance

substance containing gelatinous matter, such as bits of skin, strong glue, &c. The tanning principle precipitated itself with the gelatinous matter, and the bath held in solution only the principles which produce a lively and strong yellow. By the help of this process, colours as bright as those communicated by yellow weed (*reseda luteola*) and quercitron bark, may be procured from several vegetables.

NEW COINAGE.

We have already mentioned (p. 220.) that it was proposed to improve our coin, and that the subject was referred to the Royal Academy. The following circular notice has been since issued to the academicians.

“ Royal Academy, August 20th, 1793.

“ SIR,

“ The Lords of the Committee of Council having expressed a desire that the gold and silver coins of this kingdom should have every improvement which the present state of the arts can afford, and the Royal Academy having agreed to take the same into their consideration, the president has accordingly ordered a general meeting of the academicians on the 20th of September next, at seven o'clock in the evening, to receive the designs or models of such of the members of the academy as will then offer; which designs or models are intended by the lords of the committee to be presented for his majesty's inspection, previous to their being carried into effect.

“ The coins intended are as follow—

Gold—A two guinea piece, a guinea, and a half guinea.

Silver—Five shilling piece, half crown ditto, one shilling, and six-pence.

The head of his present majesty, the arms of the realm, the lion, the crown, and Britannia.

“ In forming the designs or models, it is desired that attention be paid to the roundness and simplicity of the coin;

to

to the whole or part of the inscription on the same, and to guard against the wearing or filing.

“JOHN RICHARDS, R. A. Secretary.”

In consequence of the above notice, a meeting took place at the time appointed, when several drawings and models were produced, which were afterwards forwarded to the Lords of the Committee of Council, for his majesty's inspection.

Much ought to be done. If historical facts are not to be recorded on our coins, the whole intellect and abilities of the artists of Great Britain ought to be concentrated as it were in one focus to produce the *acmé* of excellence.

SURGERY.

We have to announce that a considerable improvement has lately been made on the German key for extracting teeth. Mr. Charles Brown, surgeon, having for some time past turned his attention to the structure and mechanical powers of those instruments used in the lesser operations of surgery, it appeared to him, that the German-key most commonly in use, notwithstanding the various improvements it has undergone, partly by professional men, and partly by instrument-makers, was not well calculated to extract teeth with safety and ease. Having had great experience in this particular branch of surgery, he endeavoured, and with success, to remedy the defects that were still obvious in the instrument. As the one produced by Mr. Brown possesses in an eminent degree many advantages over all others, we shall, in a future number, present our readers with a description of it, which the ingenious inventor has promised to furnish us with, illustrated with an engraving. In the mean time, such of our readers as wish for a more early knowledge of its structure, may see one of them at Mr. Whitford's, surgeon's instrument-maker, in the Cloisters, St. Bartholomew the Less, Smithfield.

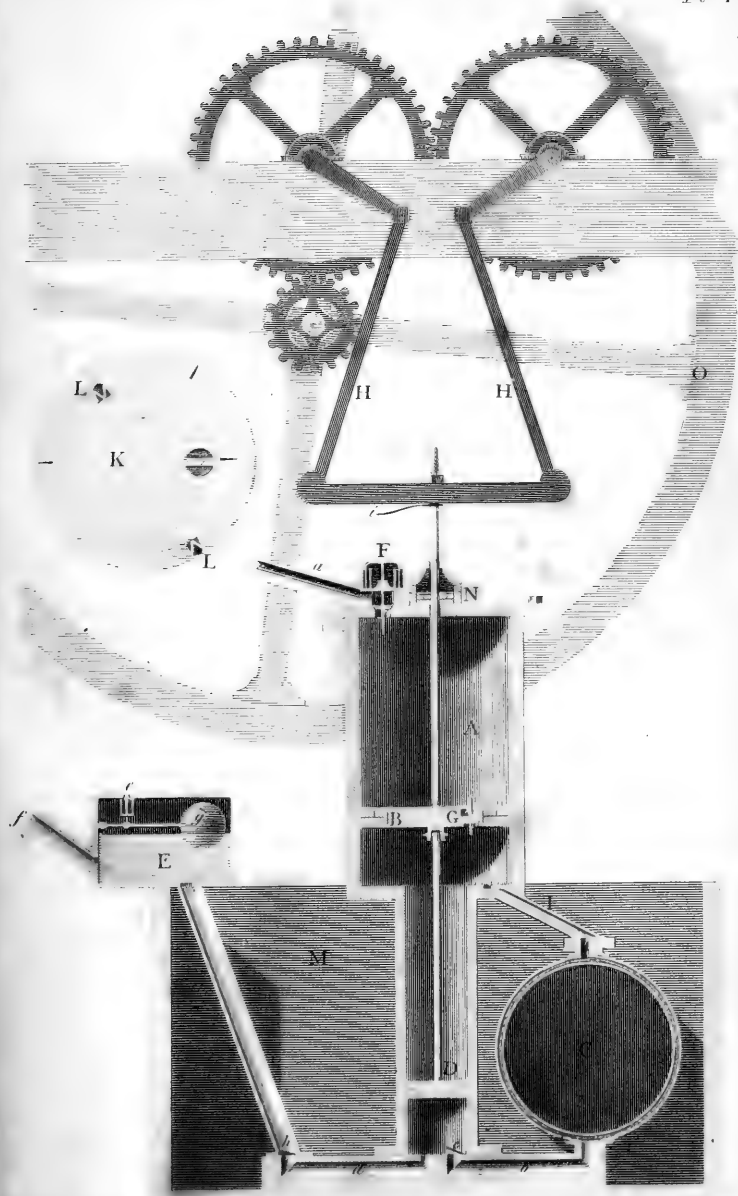




Fig. 3.



Fig. 2.

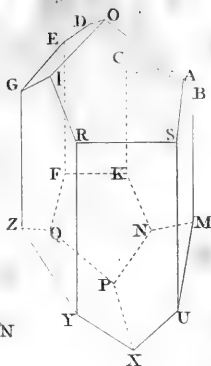


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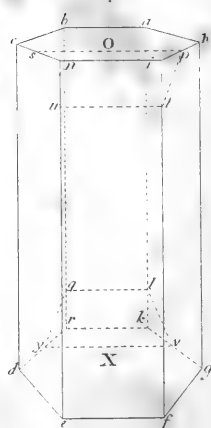


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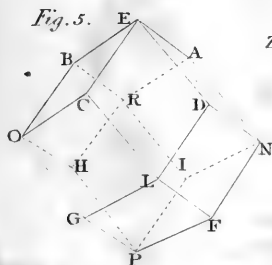


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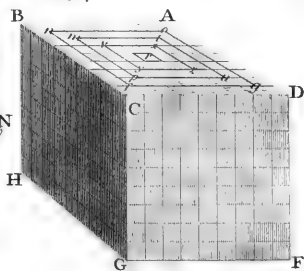


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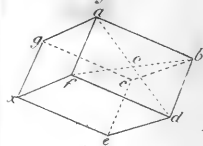


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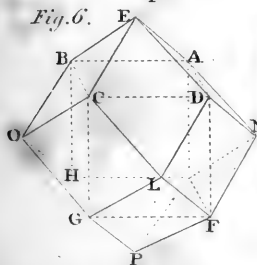


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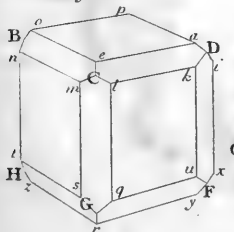


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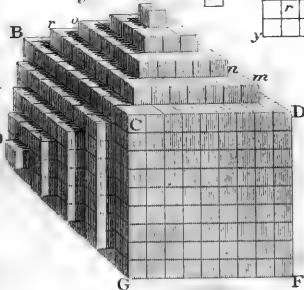


Fig. 11.



Fig. 10.



Fig. 8.

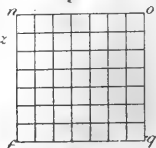
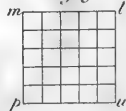
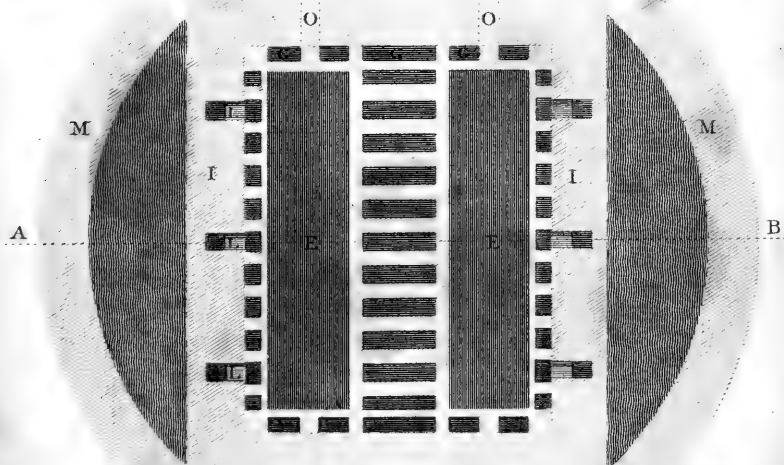
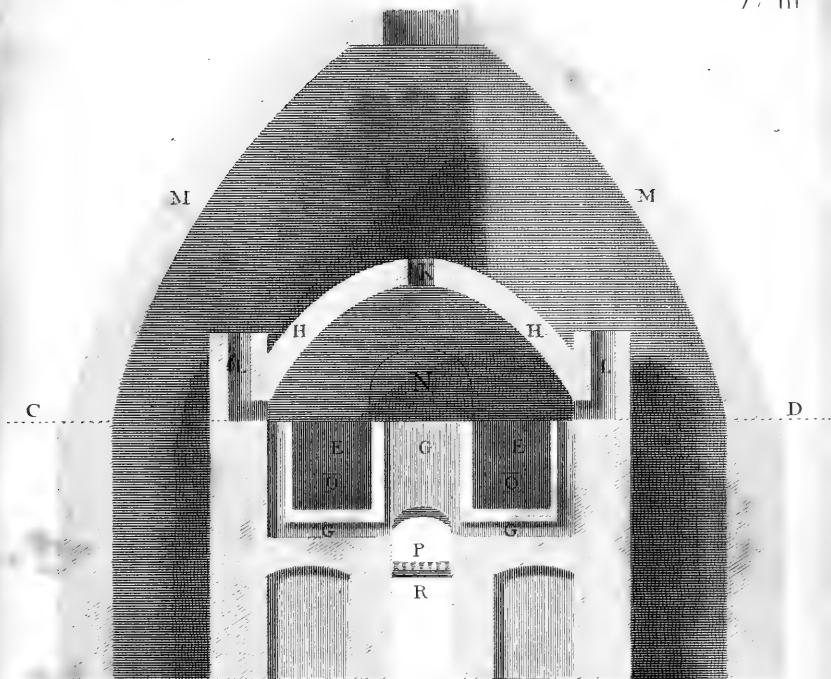


Fig. 9.



W. Lowry sculp.





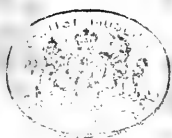
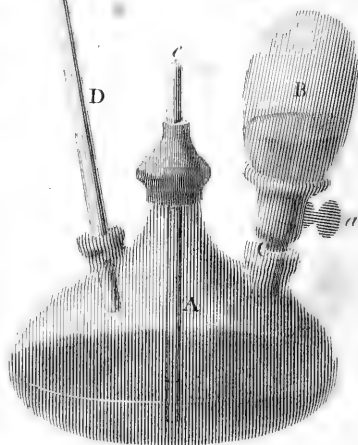
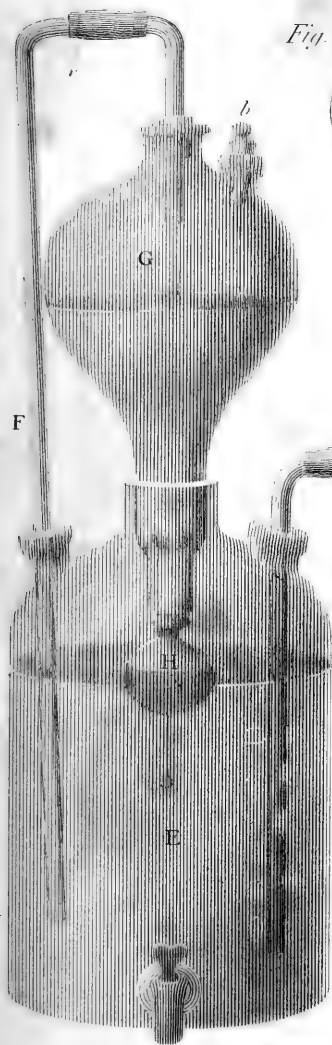


Fig. 3.



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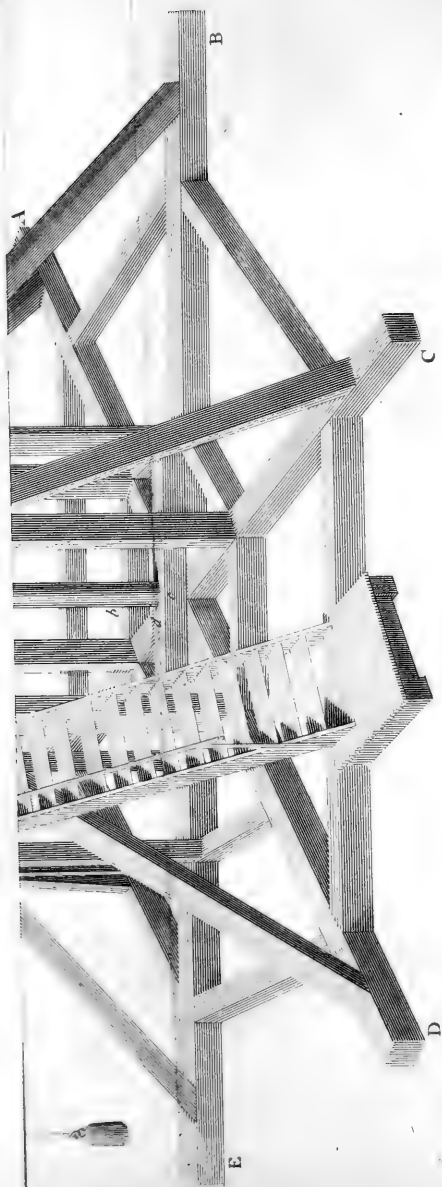
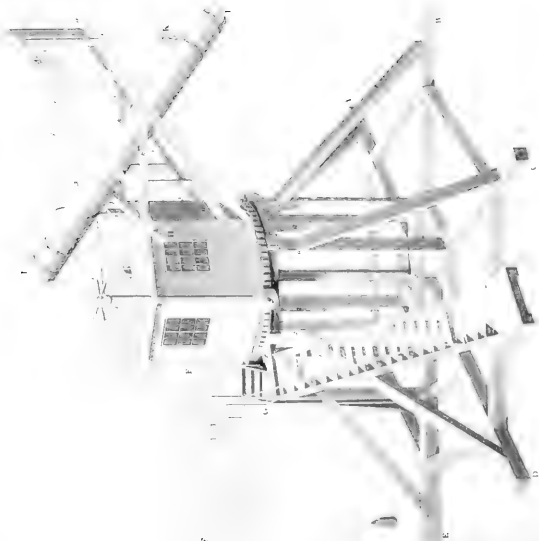


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PHILOSOPHICAL MAGAZINE.

Fig. 16.

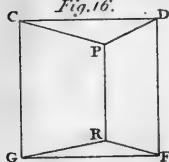


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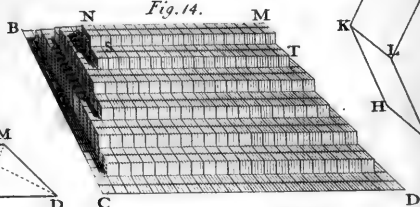


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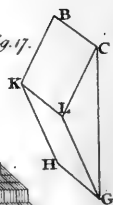


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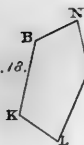


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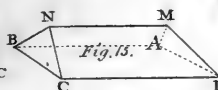


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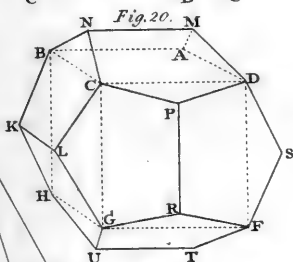


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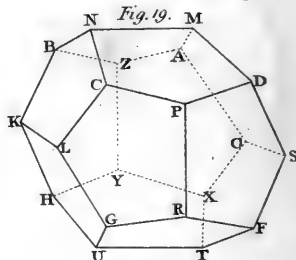


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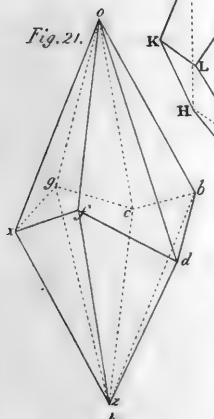


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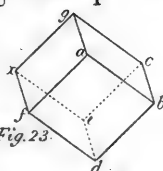


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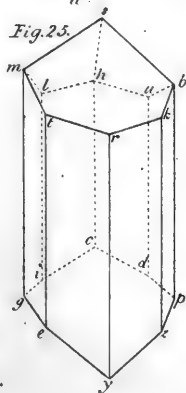


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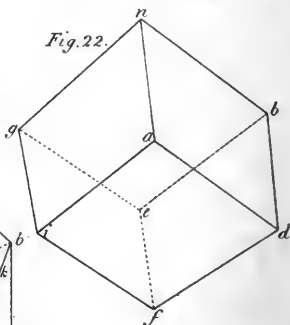


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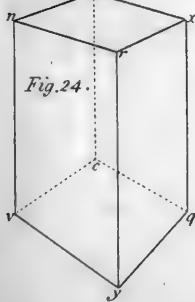
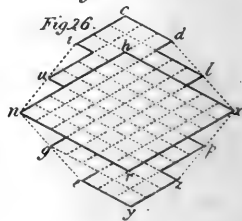
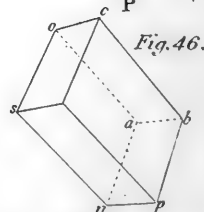
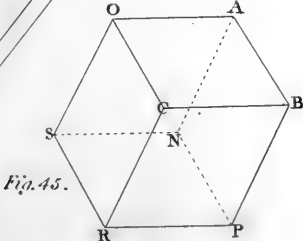
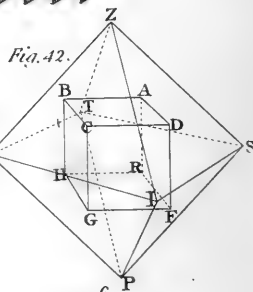
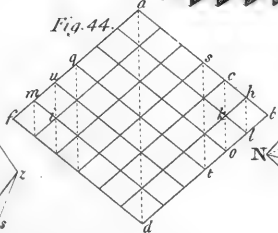
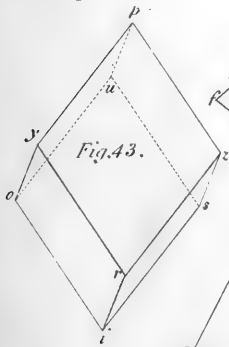
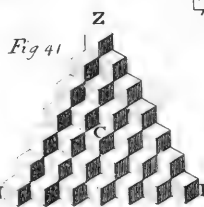
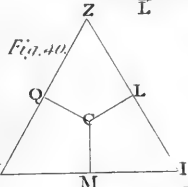
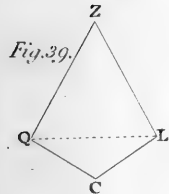
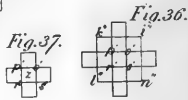
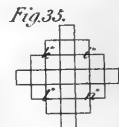
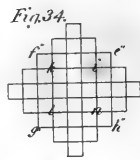
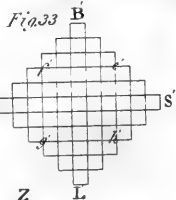
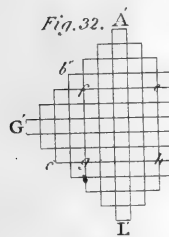
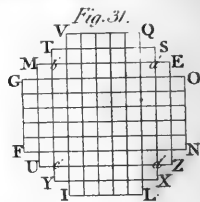
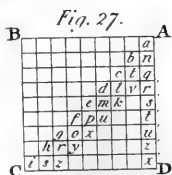
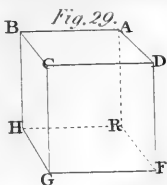
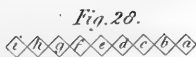
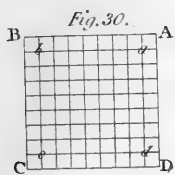


Fig. 26.









Jumping Mouse of Canada.

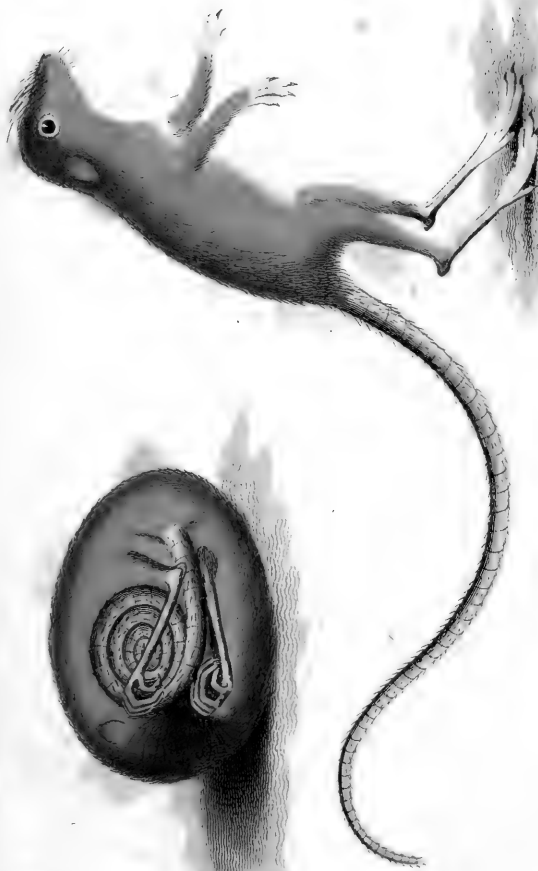




Fig. 49.

Fig. 47.

Fig. 50.

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Fig. 62.

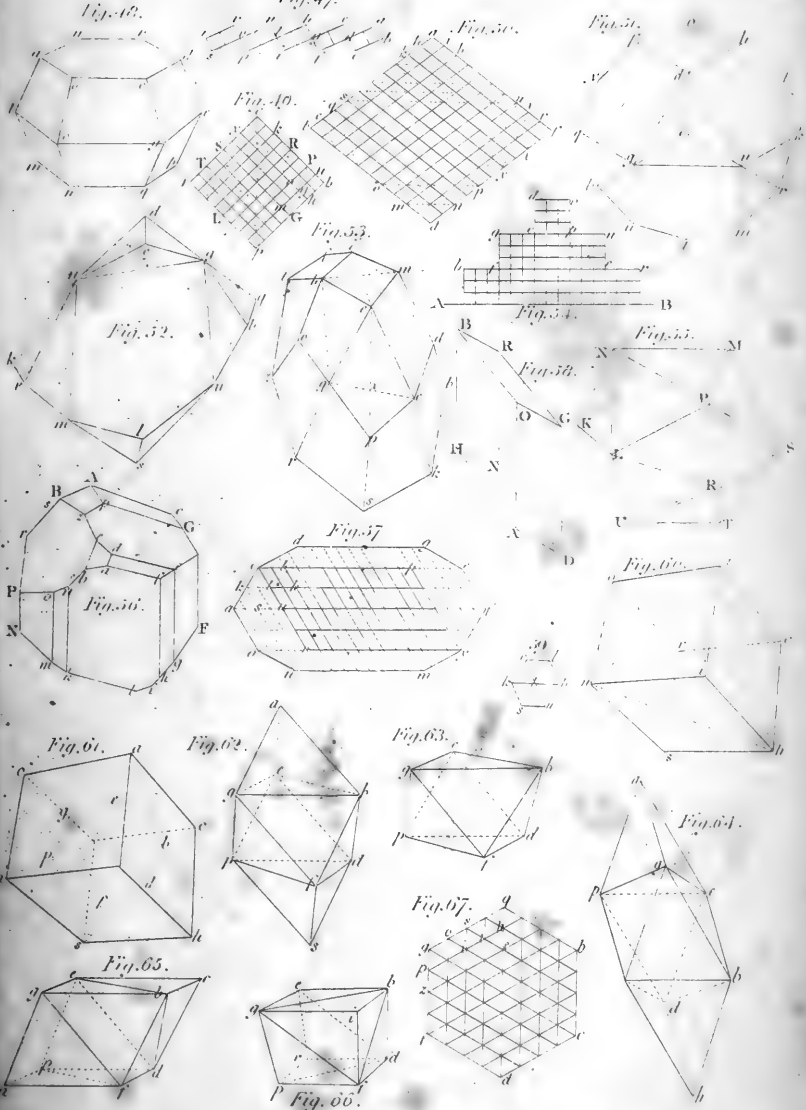
Fig. 63.

Fig. 64.

Fig. 65.

Fig. 67.

Fig. 66.





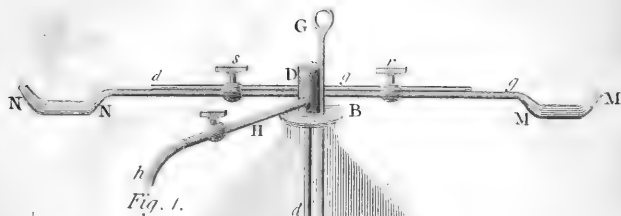


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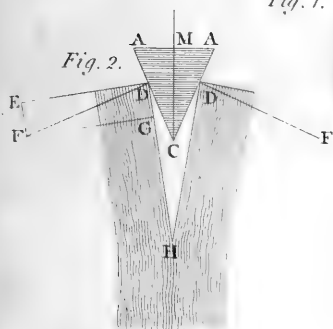


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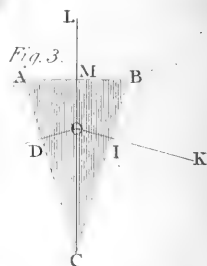


Fig. 3.

Fig. 5.

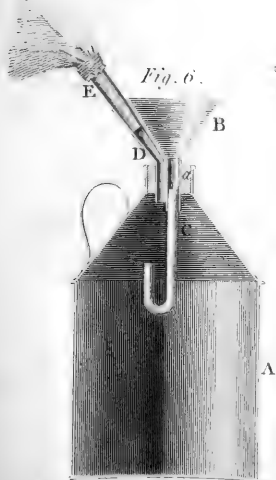


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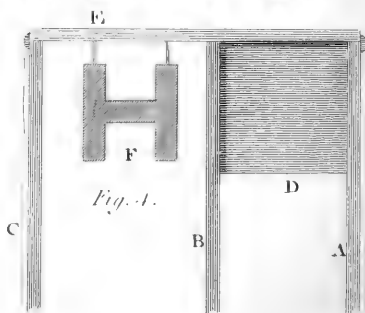
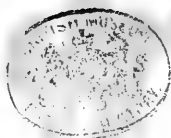


Fig. 4.







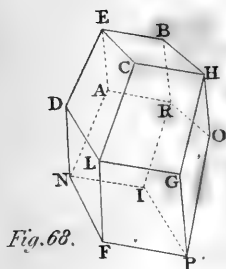


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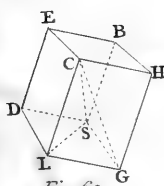


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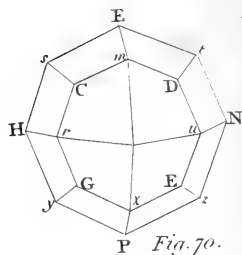


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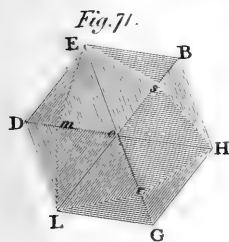


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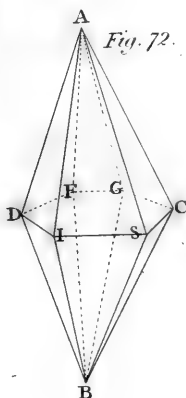


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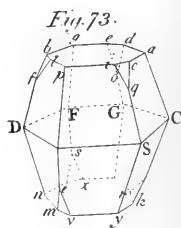


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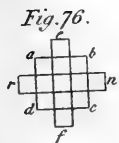


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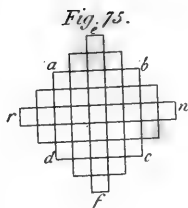


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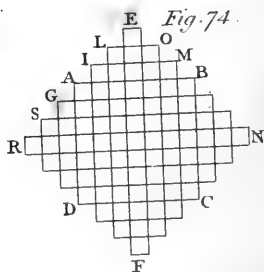


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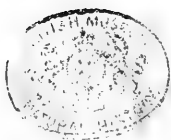




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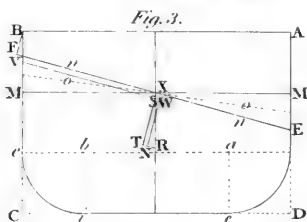
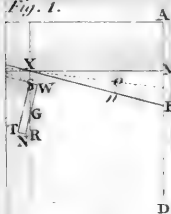


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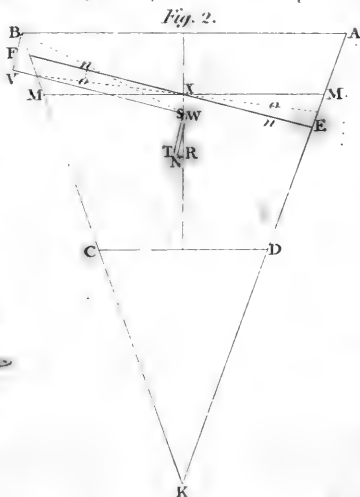
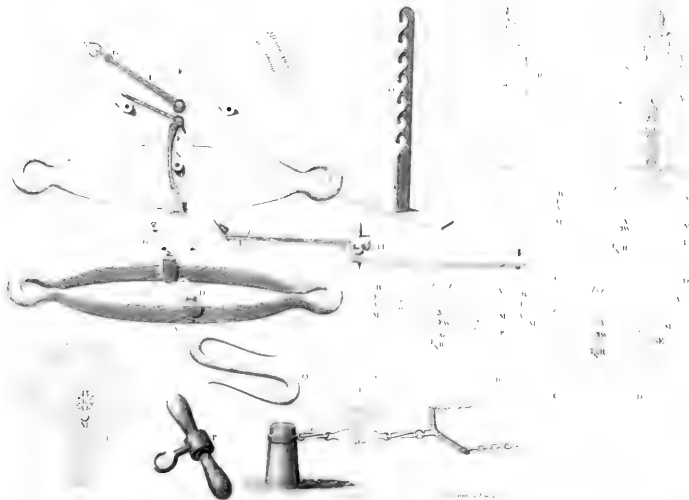


Fig. 2.



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END OF THE FIRST VOLUME.

ERRATA.

Page 3, l. 34, for *axles* read *axes*.—P. 13 last line, for *potashev* and *wine stone*, read *potash* and *crude tartar*.—P. 60, l. 22, for 12 *bours*, read 10 *bours*.—P. 82, l. 18, for *mine*, read *ore*.—P. 101, l. 8 and l. 12, for *strontiat*, read *strontian*.—P. 145, l. 22, for *ether of witril*, read *fulphuric ether*.—P. 311, l. 29, for *oxydated*, read *oxygenated*.—P. 332, line 5, after *muriat of*, insert *mercury or*.—P. 376, l. 17, dele *the*.—P. 373 in the note, for *lex*, read *lilax*.

The Binder is desired to place the Plates, in their order, before the Index, at the end of the Volume.

